2015-1743, -1744

United States Court of Appeals for the Federal Circuit

INTERNATIONAL SECURITIES EXCHANGE, LLC,

Appellant,

v.

CHICAGO BOARD OPTIONS EXCHANGE, INC.,

Appellee.

Appeals from the United States Patent and Trademark Office, Patent Trial and Appeal Board in Nos. IPR2014-00097 and IPR2014-00098.

OPENING BRIEF OF APPELLANT

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September 18, 2015

CERTIFICATE OF INTEREST

Counsel for Appellant International Securities Exchange, LLC certifies the following:

1. The full name of every party or amicus represented by us is:

   International Securities Exchange, LLC

2. The name of the real party in interest (if the party named in the caption is not the real party in interest) represented by us is:

   N/A

3. All parent corporations and any publicly held companies that own 10% or more of the stock of any party represented by us are:

   Parent Companies: International Securities Exchange Holdings, Inc.; U.S. Exchange Holdings Inc.; Eurex Frankfurt AG; Deutsche Borse AG.

   No publicly owned company directly owns more than 10% of International Securities Exchange, LLC's stock. Deutsche Borse AG is a publicly owned German company on the Frankfurt Stock Exchange.

4. The names of all law firms and the partners or associates that appeared for the parties now represented by us in the trial court or expected to appear in this court are:

   Winston & Strawn LLP: Michael M. Murray, Michael J. Scheer, Geoffrey P. Eaton, Bryan N. DeMatteo

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STATEMENT OF RELATED CASES

This set of consolidated appeals arises from the decisions of the Patent Trial and Appeal Board ("the Board") in *inter partes* review proceedings of U.S. Patent Nos. 7,356,498 (IPR2014-00097) and 7,980,457 (IPR2014-00098). No other appeal in or from the same *inter partes* review proceedings before the Board were previously before this or any other court.

Pending before this Court is another set of consolidated appeals (Appeals 2015-1728, 2015-1729, and 2015-1730), which arises from the decisions of the Board in Covered Business Method (CBM) patent reviews of U.S. Patent Nos. 7,356,498 (CBM2013-00049), 7,980,457 (CBM2013-00050), and 8,266,044 (CBM2013-00051). The Board in those reviews held that all claims of the above patents are unpatentable under 35 U.S.C. § 101 for claiming unpatentable abstract ideas.

The above patents are also the subject of a district court litigation currently before the United States District Court for the Southern District of New York. In this litigation, Chicago Board Options Exchange, Inc. has accused International Securities Exchange, LLC of infringing the above patents. This litigation has been stayed pending completion of the CBM reviews.

JURISDICTIONAL STATEMENT

The Board had jurisdiction over Appellant's respective petitions under 35 U.S.C. § 6. The Board issued Final Written Decisions on March 2, 2015. This Court has jurisdiction under 28 U.S.C. § 1295(a)(4)(A) and 35 U.S.C. § 329.

STATEMENT OF ISSUES

1. Whether the Board committed legal error in the Final Written Decisions by modifying its uncontested original constructions for "risk level" and "aggregate risk level," to impose additional limitations not supported by the claims or the specifications, and if so, whether the Tilfors prior art teaches those elements under the correct constructions.

2. Whether substantial evidence supports the Board's finding that Tilfors does not disclose "determining a specific 'risk level' value, '1.'"

3. Whether substantial evidence supports the Board's finding that Tilfors does not disclose "determining a risk level and an aggregate risk level associated with said trade" under the Board's modified constructions.

STATEMENT OF THE CASE

This appeal arises from two petitions for *inter partes* review of U.S. Patent Nos. 7,356,498 ("the '498 Patent") and 7,980,457 ("the '457 Patent"), assigned to Chicago Board Options Exchange, Inc. ("CBOE" or "Patent Owner"). On November 12, 2013, International Securities Exchange, LLC ("ISE") filed petitions seeking review of claims 1-28 of the '498 Patent and claims 1-7 of the '457 Patent. A0054-55; A0121-22. On May 22, 2014, the Board instituted *inter partes* reviews of claims 1, 8, 9, 11, 14, 15, and 23 of the '498 Patent on two grounds (anticipation and obviousness) and claim 1 of the '457 Patent on one ground (anticipation), all of which relied, in whole or in part, on prior art reference U.S. Patent No. 6,405,180 ("Tilfors"). A0349; A0369.

The Board issued Final Written Decisions on March 2, 2015. The Board held that ISE did not demonstrate by a preponderance of the evidence that claims 1, 8, 9, 11, 14, 15, and 23 of the '498 Patent and claim 1 of the '457 Patent are invalid in view of the prior art. A0019; A0039. The crucial holding in both Decisions was a finding by the Board that Tilfors does not disclose the step of "determining a risk level and an aggregate risk level associated with said trade," as recited by the independent claims of the '498 and '457 Patents. A0007-19; A0027-39. This set of consolidated appeals follows.

STATEMENT OF FACTS

I. Background

The ’498 and ’457 Patents relate to methods for managing the financial risks faced by market makers in the automated trading of options contracts on an automated (electronic) trading exchange. A0171, 1:8-12; 2:49-67.[1] Understanding the patents-in-suit and the relevant art requires a brief background explanation of the following: (A) options trading on non-automated exchanges; (B) options trading on automated exchanges; (C) a known problem with automated exchanges and (D) how the prior art solved this problem before the ’498 and ’457 Patents.

A. Options Trading and Open Outcry Exchanges

Options contracts (generally referred to as “options”) are securities that convey the right, for a specified period of time, to buy or sell an underlying stock, commodity, or other security at a fixed price. A0171, 1:18-21. To provide a stable and liquid market for options, certain individuals or financial firms serve as “market makers,” who ensure that the market for a particular kind of option is open by providing quotes to buy and sell options. A0171, 1:44-49; A0208, 1:22-23; A0222, ¶ 20; A0284, ¶20. A quote includes a price, a quantity and an expiration date at which particular options can be bought or sold. For example, on July 19,

[1] The ’498 and ’457 Patents share a substantially identical specification. Citations to the specifications will be made in reference to the ’498 Patent.

2013, options to buy or sell 100 shares of IBM common stock up to or on the expiration date August 17, 2013 were available with a strike price of 190, and the per-share options prices were $5.30 to buy and $2.29 to sell. A0221, ¶18; A0283, ¶18. This means that a trader could pay $5.30 per option for the right to buy 100 shares of IBM stocks at $190.00 per share on or up to August 17, 2013. A0221, ¶18; A0283, ¶18. A trader is always able to buy or sell a particular option at the prevailing market price set by the market maker, thereby ensuring that the market remains liquid. A0222, ¶ 21; A0285, ¶ 21.

Market making involves many types of risk. For example, a market maker faces the risk that the prices of her quotes are too favorable for the traders and that she will be obligated to buy or sell the underlying security at a financial loss. A0171, 1:30-35; A0222, ¶ 22; A0285, ¶ 22. To be successful, a market maker must carefully manage her risk by monitoring market conditions as her quotes are traded and making appropriate adjustments to the price or volume of her remaining quotes in response to accumulated risks. A0171, 1:49-55; A0208, 1:34-37, 2:45-56. Risk monitoring typically involves quantifying risk associated with individual trades as they execute and understanding the aggregate risk the market maker has accumulated over a course of trading. A0209, 4:46-62.

Market makers determine their risks in many different ways. Calculating risk can be as simple as counting the total number of options that have been sold or

bought in a given time period or within a certain number of trades. A0177, 14:19-22. For example, a large number of options sold in consecutive trades at a certain price may indicate that the price set by the market maker is too low, and the market maker should increase the price to reduce her risk. A0224, ¶ 25; A0286, ¶ 25. For more sophisticated risk management calculations, well-known financial algorithms have long existed to determine risk based on the sensitivity of the option price with respect to changes in the underlying asset's value or based on numerous other factors. A0176, 12:15–A0177, 13:3.

Prior to the development of automated exchanges, options were traded on manual, so-called "open outcry" exchanges. In such an exchange, options were traded on a trading floor with the market makers and traders communicating verbally or visually. A0171, 1:43-49; A0223, ¶¶ 23-24; A0286, ¶¶ 23-24. Because all orders came to the floor, each market maker could accurately track order flow and exercise discretion over how pricing should be adjusted as trades were made. This allowed the market maker to control the risk of her market making activities. A0223-24, ¶¶ 24-26; A0286-87, ¶¶ 24-26.

For example, an exchange may require a market maker to always have at least 100 options in her quote in order to provide the above described liquidity. If the volume of the quote drops below 100, the rules of the exchange require the market maker to add volume to her quote to bring it back up to the 100 option

minimum. Based on the risk accumulated over the course of trading, the market maker may change the price of the options she has to add to her quote because of the required exchange minimum. A0209, 4:53-62. The market makers' control over the price and number of options traded allows the market makers to adjust their quotes to favor trades that would hedge their risk. A0171, 1:49-55.

B. Automated Exchanges

An automated exchange is a computer-based trading system that accepts and records quotes and automatically matches them with orders that enter the system. A0171, 1:56-61. The use of computers allows trades to be matched and executed much more rapidly than in open outcry exchanges. A0171, 1:61-65. This increased speed, however, does not change the fundamentals of options trading and risk-management by market makers. Market makers provide the same liquidity function and face the same need to manage risks on automated exchanges as they did in open outcry exchanges. A0225, ¶ 27; A0288, ¶ 27. Just like market makers in open outcry exchanges, market makers in automated exchanges must manage the risks associated with their quotes as trading proceeds, constantly evaluating what price or volume changes should be made to their quotes to maintain an acceptable level of risk. A0224-25, ¶¶ 26-27; A0287-88, ¶¶ 26-27. And just as with open outcry exchanges, automated exchanges require that market makers maintain a minimum number of quotes in the system. A0209, 4:37-43.

C. Limited Control Over Risk Management in Automated Exchanges

As admitted by the ’498 and ’457 Patents, a known disadvantage of automated exchanges is that the exchanges execute trades so rapidly that market makers may not be able to timely adjust their quotes in response to increased risks. A0171, 1:65-2:5. Similarly, an automated exchange will automatically add volume to a market maker’s quote in order to maintain the minimum volume required by the exchange. A0209, 4:37-43. The speed at which an automated exchange executes trades or adds volume to a market maker’s quotes simply does not leave much time for a market maker to determine her accumulated risk and make timely adjustments to her quotes. Thus, automated exchanges can limit the market maker’s ability to manage her risks. A0171, 1:56-58.

D. Tilfors’ Automated Risk Management in Automated Exchanges

The ’498 and ’457 Patents have effective filing dates of December 30, 1999. A0162. More than a year before that, in November of 1998, Tilfors had already recognized and filed a patent application relating to problems associated with automating the trading part of the options exchange process without automating the risk management part:

> [I]f there is a delay in the communication path between a market maker and the automated exchange system or a market maker is slow to enter his new prices into an existing automated system the system will automatically match bids, even though this never was the intention of the market maker only being slow to enter his new prices or the new prices having been delayed for some reason.

A0200; A0208, 1:37-44. Before the '498 and '457 Patents, Tilfors solved this problem by integrating automated risk management functionality directly into the automated exchange. Tilfors expressly describes allowing the exchange to automatically determine risks associated with trades as they execute and modify a market maker's quote if the trades result in unacceptable aggregate risk for the market maker. A0208, 2:21-40; A0209, 4:46-62; A0239, ¶ 50; A0300, ¶ 47.

In the embodiment relied on in the Petitions and the Institution Decisions, Tilfors discloses two techniques for automatically managing the risks of a market maker when a trade reduces the volume of a quote below the minimum volume required by the exchange, and the exchange is automatically adding volume to the market maker's quotes: a "tick-worse" technique and a "step-up" technique. A0072-74; A0140-43; A0335-36; A0364-65.

1) Tilfors' "tick-worse" technique

In Tilfors' first risk management technique, if a trade reduces the volume of the quote to be more than "a little smaller than" X, the minimum volume defined by the exchange, such that a large volume of contracts will be automatically added to the quote, the system adds this volume at a "worse price." This is known as "tick-worse." The price is worse for the trader and is actually better for the market

maker, which is why "tick-worse" helps the market maker.[2] A0209, 4:50-53; A0210, 6:48-51. The "little smaller than" value and the tick-worse price are parameters set by the market maker. A0208, 2:28-38. By changing the price in the volume added to the quote in response to the trade, the market maker's risk of loss is reduced.

2) Tilfors' "step-up" technique

In the second risk management technique, if a trade reduces the volume of the quote to only "a little smaller than" X, such that only a small volume of contracts will be automatically added to the quote, Tilfors adds this volume in the quote at the *current* price. This is known as a "step-up." A0209, 4:47-50; A0210, 6:45-48.

Tilfors recognized that traders, with an understanding of the "tick-worse" and "step-up" techniques, would try to game the system by using a series of consecutive small orders (triggering multiple step-ups at the same price) to buy a large volume of options at the same price rather than using a single large order that would trigger a tick-worse price. A0209, 4:53-62; A0872-73; A0891-92. Left unchecked, these consecutive small orders, triggering multiple automatic step-ups in volume, would leave the market maker's risk of loss unbounded. Tilfors

[2] A "worse price" is a higher price if the market maker is selling the option, and a lower price if the market maker is buying the option.

recognized this risk to the market maker and prevents such gaming of the system by: (1) counting each trade that triggers an automated step-up as increasing the risk that a trader is trying to game the system; (2) keeping a running count of the number of consecutive step-ups that have occurred at the same price; and (3) executing the risk management tick-worse price change when the aggregate risk of consecutive trades rises above the market maker's risk threshold (*i.e.*, the point at which the market maker believes the trader is trying to game the system). A0209, 4:53-62; A0210, 6:51-53.

Accordingly, the market maker, knowing the current price she is offering in a quote, manages her risk by setting the "step-up" parameters of "a little smaller than" X, the "number of consecutive times" that she will allow the exchange to add volume at the same price (a "step-up"), and the "tick-worse" price. A0208, 2:14-38; A0209, 4:46-62. These parameters are predefined by the market maker at least before the trading day starts. A0208, 2:29-31. The following example illustrates how Tilfors' automatic risk management works: A0875-76; A0894-96.

- Assume that the minimum volume X required by the exchange is 50 options and the market maker has a quote in the system for 60 options at a current price of $9.00 set by the market maker.
- The market maker sets her "little smaller than" X value in her step-up parameters to be 40 options (*i.e.*, such that the maximum number of

options that can be added to the quote at the same price by a step-up is 10 options, the difference between the exchange minimum X of 50 and the market maker's "little smaller than" X value of 40). The market maker further sets the "number of consecutive times" a step-up is allowed to add volume at the same price to two times (*i.e.*, the market maker's risk threshold is 2) – after which the market maker believes the trader is trying to game the system and will only add volume to her quote at the "tick-worse" price, which the market maker could set to, *e.g.*, $9.10, an increase over the current price of $9.00.

- A trader enters a first order for 20 options at the current price. This order reduces the market maker's quote from 60 to 40 options, which is below the exchange minimum of 50 and equal to the market maker's "little smaller than" X value of 40 options. A step-up is triggered at the current price of $9.00 since an addition of 10 options is required to bring the quote back up to the exchange minimum of 50. The triggering of the step-up causes the exchange to count this trade as increasing the market maker's risk level by 1, and the aggregate risk level (the running count of the number of consecutive step-ups) is also at a value of 1.

- The trader makes a second order of 10 options that again reduces the quote to 40 options. A second step-up is triggered at the current price of $9.00 since another addition of 10 options is required. Since this trade triggers a consecutive step-up at the same price, the exchange determines this trade as another increase in the market maker's risk and the aggregate risk level count is now at a value of 2.
- The trader then makes a third order of 10 options at the same price that again reduces the quote to 40 options. Another step-up is triggered since addition of another 10 options is required to get back up to the exchange minimum. The system, continuing its counting of trades triggering step-ups, adds another risk level of 1 to the aggregate risk level count, which is now at a value of 3. Because the current aggregate risk level of 3 is greater than the market maker's predefined risk threshold of 2, Tilfors does not use the current price of $9.00 for this third step-up. Instead, Tilfors uses the tick-worse price of $9.10 to modify the market maker's existing quote. This addition of volume to the quote and modification of the price to one more favorable to the market maker reflects the market maker's prior determination that more than 2 consecutive step-ups in volume at the same price indicates that the trader is trying to game the system. The market

> marker has therefore managed her risk by requiring the exchange to add volume to her quote at a "worse" price (*i.e.*, one that is better from the market maker's point of view).

Thus, Tilfors discloses automated risk management by the exchange. The exchange determines a risk level associated with each trade (based on whether the trade triggers a step-up), determines an aggregate risk level (by counting the consecutive number of times trades trigger a step-up at the same price) and automatically modifies a quote (adding additional volume to the quote at a worse price) if the aggregate risk level exceeds the market maker's risk threshold (maximum consecutive number of times step-up is allowed to add volume to the quote at the same price).

II. The '498 and '457 Patents Claim Automated Risk Management in Automated Exchanges

Like Tilfors, the later-filed '498 and '457 Patents recognize that the automation of the exchanges can limit the market makers' ability to manage their risks and thus hinders the liquidity of the market. A0171, 1:65-2:5, 2:24-33. And like Tilfors, the '498 and '457 Patents propose to solve this problem by integrating automated risk management functionality directly into the automated exchange. A0162, Abstract; A0171, 2:39-41. Claim 1 of the '498 Patent, reproduced below, is illustrative of the claims at issue. The central limitation at issue in this appeal is "determining a risk level and an aggregate risk level associated with said trade."

> 1. A method of modifying quotes in an automated exchange trading system comprising the steps of:
>
> receiving orders and quotes, wherein specified ones of said quotes belong to a quote group, and wherein said specified ones of said quotes have associated trading parameters comprising a risk threshold;
>
> generating a trade by matching said received orders and quotes to previously received orders and quotes;
>
> storing each of said orders and quotes when a trade is not generated;
>
> determining whether a quote having associated trading parameters has been filled as a result of the generated trade, and if so, ***determining a risk level and an aggregate risk level associated with said trade***;
>
> comparing said aggregate risk level with said risk threshold; and,
>
> automatically modifying at least one of the remaining said specified ones of said quotes in the quote group if said threshold is exceeded.

In short, the '498 and '457 Patents claim the use of automated exchanges to (1) generate trades by matching orders and quotes, (2) determine risk and aggregate risk of trades, and (3) modify a quote if the aggregate risk exceeds a risk threshold.

III. The Board Instituted *Inter Partes* Review Based on Tilfors' Disclosure of Determining Risk and Aggregate Risk

In its Decisions to Institute, the Board construed two limitations using the broadest reasonable interpretation standard:

Claim Term	Construction
"risk level . . . associated with said trade"	"a calculated, measured, or otherwise obtained value of exposure to the possibility of loss related to said trade"
"aggregate risk level associated with said trade"	"a calculated, measured, or otherwise obtained aggregate value (e.g., combination, sum, weighed sum, difference) of exposure to the possibility of loss related to such trade"

A0330-32; A0359-61.

Using these claim constructions, the Board found that Tilfors disclosed "determining a risk level and an aggregate risk level associated with said trade." A0335-36; A0364-65. The Board agreed with ISE that Tilfors (1) determines a "risk level" based on whether a trade triggers a step-up and (2) determines an "aggregate risk level" by counting the number of step-ups. A0335-36; A0364-65. In particular, the Board found:

> whether or not a trade triggers a step-up in volume is a calculation of the market maker's exposure to the possibility of loss related to a trade, i.e., the claimed "risk level." Ex. 1004 ¶ 51. In addition, the number of step-ups, i.e., volume increases, applied against a quote, which the Tilfors system tracks, is a calculation of the sum of a market maker's exposure to the possibility of loss because it is an indication of how many times volume has been added to an existing quote, i.e., "aggregate risk level."

A0335-36; A0365.

IV. The Board Modified Its Constructions in the Final Written Decisions

Neither party contested the Board's claim constructions, and in the Final Written Decisions ("Final Decisions"), the Board purported to apply those same

constructions again. A0007, 0014; A0027, 0034. In fact, however, the Board's opinions make it clear that in rejecting the anticipation challenge, the Board applied different, narrower constructions of "risk level" and "aggregate risk level." Specifically, the Board concluded for the first time that a "risk level" required not only a "calculated, measured, or otherwise obtained value of exposure to the possibility of loss" from a trade, but also that calculation of the value must be based on "critical information, such as volume traded, volume remaining in the market maker's quote, price of the trade, etc." A0014; A0034. These additional, narrower, requirements are not present in the claims or supported by the specifications, and seem to have been drawn from attorney argument presented by CBOE's counsel. A0014; A0034 (both citing solely to CBOE's counsel's arguments in the hearing).

Having altered its own, uncontested claim constructions, the Board held that Tilfors does not disclose "determining a risk level . . . associated with said trade" under its modified, narrower constructions. A0014-17; A0034-37. Stating that a "risk level" for a particular trade could not be "calculated without taking into account critical information, such as volume traded, volume remaining in the market-marker's quote, price of the trade, etc.," the Board ruled that Tilfors does not teach a "risk level" because its step-up feature does not take trading volume into account. A0014-16; A0035-36. The Board also held that while Tilfors keeps

track of the number of step-ups, Tilfors does not disclose "determining a specific 'risk level' value, '1,'" for each trade triggering a step-up. A0014; A0034. The Board then went further, and held that Tilfors also does not disclose "determining . . . an aggregate risk level associated with said trade." A0017-18; A0037-39.

Based on the above, the Board held that the independent claims of the '498 and '457 Patents were not anticipated by Tilfors. A0019; A0039. The Board did not separately address how the prior art renders the dependent claims of the '498 Patent obvious. Rather, the Board simply stated that the dependent claims of the '498 Patent were not obvious in view of Tilfors and another prior art reference. A0018-19.

SUMMARY OF THE ARGUMENT

1) The Board committed legal error in its Final Decisions by modifying and narrowing its uncontested claim constructions from the Institution Decisions. In the Final Decisions, the Board added the additional limitation that the determination of a "risk level" and an "aggregate risk level" had to take into account "critical information such as volume traded, volume remaining in the market maker's quote, price of the trade, etc." These additional limitations were not in the Board's original broadest reasonable interpretation and are not consistent with the specifications of the '498 and '457 Patents. Neither party disputed the Board's original claim constructions and no evidence was produced at trial which

necessitated the Board's narrowing of its original claim constructions. Because the Board's modified constructions are not the broadest reasonable interpretation consistent with the specifications, this Court should adopt the Board's original constructions. Under the Board's original broadest reasonable interpretations, Tilfors discloses "determining a risk level and an aggregate risk level associated with said trade."

2) There is no substantial evidence to support the Board's conclusion that Tilfors fails to disclose "determining a specific 'risk level' value, '1,'" for each trade triggering a step-up. The Board failed to provide any rationale or support for its conclusion. Tilfors determines a market maker's risk of loss by calculating the risk that a trader is attempting to game the system. This risk is measured by counting the number of consecutive trades that trigger a step-up at the same price. Each consecutive trade that triggers a step-up increases the count by a value of "1" until the market maker's risk threshold of the number of consecutive step-ups is exceeded. Thus, Tilfors determines a risk level value of 1 for each trade triggering a step-up.

3) There is no substantial evidence to support the Board's conclusion that Tilfors fails to disclose "determining a risk level and an aggregate risk level associated with said trade" even under the Board's modified, narrowed claim constructions. Tilfors determines a risk level and an aggregate risk level by taking

into account several kinds of "critical information," including: (1) the volume remaining in the market maker's quote, (2) the minimum volume X required by the exchange, (3) the price of the trade, (4) the price of the prior trade, and (5) whether the prior trade triggered a step-up at the same price. The Board relied on inaccurate statements made by CBOE's expert witness and examples that do not comport with Tilfors' disclosures to discredit credible testimony from Dr. Maureen O'Hara, ISE's expert witness. Dr. O'Hara provided credible testimony that Tilfors discloses "determining a risk level and an aggregate risk level associated with said trade." The Board also erred by taking Dr. O'Hara's testimony out of context and ignoring her consistent testimony about how Tilfors determines a risk level and an aggregate risk level.

ARGUMENT

I. Standard of Review

This Court reviews the Board's legal conclusions de novo, and the Board's factual determinations for substantial evidence. *In re Cuozzo Speed Techs., LLC*, 793 F.3d 1268, 1280 (Fed. Cir. 2015). For issues relating to the Board's claim construction, this Court reviews underlying factual determinations concerning extrinsic evidence for substantial evidence and the ultimate construction of the claim de novo. *Id*. at 1279-80 (citing *Teva Pharmaceuticals U.S.A., Inc. v. Sandoz, Inc.*, 135 S.Ct. 831, 841 (2015)). If there is no issue as to extrinsic evidence, the

Board's claim construction is a legal question that is reviewed de novo. *Id.* at 1280.

Anticipation is a question of fact, reviewed for substantial evidence. *In re Gleave*, 560 F.3d 1331, 1334-35 (Fed. Cir. 2009). "Substantial evidence is more than a mere scintilla. It means such relevant evidence as a reasonable mind might accept as adequate to support a conclusion." *In re Gartside*, 203 F.3d 1305, 1312 (Fed. Cir. 2000) (internal quotation marks and citation omitted). Moreover, "attorney arguments are insufficient to undermine the credible testimony from [an] expert" regarding disclosure in prior art. *Suffolk Technologies, LLC v. AOL Inc.*, 752 F.3d 1358, 1367 (Fed. Cir. 2014).

II. The Board Erroneously Modified its Constructions of "Risk Level" and "Aggregate Risk Level"

A. In IPR Proceedings, the Board Must Give Claims Their Broadest Reasonable Interpretation Consistent with the Specification

The Board must give claims in IPR proceedings their broadest reasonable interpretation consistent with the specification. *In re Cuozzo Speed Techs.*, 793 F.3d at 1275-79. Modifying claim construction in a final decision is legal error if the modified construction is not the broadest reasonable interpretation consistent with the specification. *See In re Abbott Diabetes Care Inc.*, 696 F.3d 1142, 1148, 1151 (Fed. Cir. 2012)

In *Abbott*, the Board of Patent Appeals and Interferences ("BPAI") held that certain claims were properly rejected in view of the prior art. As part of its analysis, the BPAI modified its construction for the term "substantially fixed." *Id.* at 1146, 1151. The BPAI originally addressed the proper construction of the claim term "substantially fixed" to mean allowing "some movement." *Id.* at 1146. However, in the application of the construction to the teachings of a prior art reference, the BPAI modified its own construction by requiring "substantially fixed" to mean "somewhat restrained." *Id.* at 1151. This Court reversed the BPAI's decision, holding that while the BPAI's original construction was reasonable in view of the specification, the modified construction was not. *Id.*

Here, the Board committed the same legal error by modifying its constructions for "risk level . . . associated with said trade" and "aggregate risk level associated with said trade." As shown below, the Board's original constructions are the broadest reasonable interpretation consistent with the specifications of the '498 and '457 Patents. The Board's modified constructions, on the other hand, are not reasonable as they are not supported by the specifications.

B. The Board's Original Constructions Are the Broadest Reasonable Interpretation Consistent with the Specifications

The Board originally construed "risk level . . . associated with said trade" to mean "a **calculated**, **measured**, or **otherwise obtained** value of exposure to the

possibility of loss related to said trade." Similarly, the Board originally construed "aggregate risk level associated with said trade" to mean "a **calculated**, **measured**, or **otherwise obtained** aggregate value (e.g., combination, sum, weighed sum, difference) of exposure to the possibility of loss related to such trade." A0330-32; A0359-61 (emphasis added).

These broadest reasonable interpretations are consistent with the specifications of the '498 and '457 Patents. For example, the specifications do not limit the ways in which "risk level" may be determined, and explain that "risk measurement . . . may be performed using a variety of methods, and certain market-makers' trading activities may be combined for the purposes of risk exposure." A0178, 16:50-53. The specifications also note that specific values for risk determination, such as theoretical delta values or volatility parameters, may be obtained by the exchange. A0176, 12:66–A0177, 13:22.

Neither party contested the Board's claim constructions contained in the Institution Decisions and the entire trial was conducted according to these claim constructions. A0007; A0027.

C. The Board's Modified Constructions Are Not the Broadest Reasonable Interpretations Consistent with the Specifications

In the Final Decisions, the Board purported to apply its uncontested original constructions, but in fact impermissibly changed and narrowed its constructions by adding further limitations to them. In the Final Decisions, the Board narrowed the

broadest reasonable constructions for "risk level" and, by extension, "aggregate risk level," by requiring that they be calculated by "taking into account critical information, such as volume traded, volume remaining in the market-maker's quote, price of the trade, etc." A0014; A0034. It was the narrowed construction on which the Board based its determination that Tilfors does not anticipate the "determining . . . a risk level" step, explaining that because Tilfors "does not take into account the volume added to a market maker's quote when a step-up is triggered by an executed trade," ISE's anticipation argument was "indefensible." A0016; A0036. Provided below is a comparison of the Board's original and modified constructions.

Claim Term	Original Construction	Modified Construction
"risk level"	"a calculated, measured, or otherwise obtained value of exposure to the possibility of loss related to said trade"	"a calculated, measured, or otherwise obtained value of exposure to the possibility of loss related to said trade <u>that is based on critical information, such as volume traded, volume remaining in the market maker's quote, price of the trade</u>"
"aggregate risk level"	"a calculated, measured, or otherwise obtained aggregate value (e.g., combination, sum, weighed sum, difference) of exposure to the possibility of loss related to such trade"	"a calculated, measured, or otherwise obtained aggregate value (e.g., combination, sum, weighed sum, difference) of exposure to the possibility of loss related to such trade <u>that is based on critical information, such as volume traded, volume remaining in the market maker's quote, price of the trade</u>"

There is nothing whatsoever in the specifications to support the Board's additional requirement that a "risk level" be determined using "critical information" such as "volume traded, volume remaining in the market-maker's quote, price of the trade, etc.," and no evidence regarding "critical information" was ever produced at trial. The Board did not cite to the specifications, cite to any evidence developed during the trial or make any factual determinations concerning any extrinsic evidence to support its narrowed construction requiring "critical information." Instead, on page 14 of the Final Decisions, the Board supported its narrowed constructions by simply pointing to four lines of trial argument from CBOE's attorney, who asserted that looking at volume of a trade by itself is not enough to calculate risk:

> And by the way, volume itself probably isn't even enough, because if you're calculating risk, you would have to look at things like price, volume itself is certainly not the fact that there was volume, isn't going to give you any information about a calculated risk.

A1227:18-21 (cited in A0014; A0034). Based on this argument, the Board appears to have concluded—for the first time—that a "step-up" value that does not take into account trade volume, price, and so on does not genuinely measure the "risk level" of the underlying trade. Put another way, counsel for CBOE appears to have persuaded the Board that because Tilfors does not require calculation of *all kinds* of risks—or at least particular kinds of risks—it does not calculate a "risk level" at all.

But this attorney argument cannot change the disclosure of the specifications, which clearly does not require the "risk level" to be determined based on any particular kind of information about the trade. In fact, the above attorney argument that volume alone is insufficient to determine "risk level"—on which the Board expressly relied—directly contradicts the specifications of the '498 and '457 Patents, which explicitly state that risk level may be determined by looking solely at volume:

> [T]he aggregate risk measurement may be simplified by calculating the total number of put or call contracts (or deltas) that have been sold or bought within a given time frame or within that last N trades.

A0177, 14:19-22.

Thus, the Board committed legal error by modifying its claim constructions in the Final Decisions. The Board's changed constructions are not the broadest reasonable interpretations consistent with the specifications, and the Court should adopt the Board's original, uncontested constructions.

III. Under the Proper Constructions, Tilfors Discloses "Determining a Risk Level and an Aggregate Risk Level Associated with said Trade"

Under the Board's original constructions, Tilfors discloses "determining a risk level and an aggregate risk level associated with said trade." Tilfors discloses that if "the step up parameter has been used to generate more volume a number of consecutive times at the same price, the one tick worse parameter can be used." A0209, 4:53-56. Doing so manages the market maker's risk by preventing a trader

from gaming the system by using multiple consecutive small orders to buy a large volume of options at the same price. A0209, 4:58-62.

In the embodiment relied on in the Petitions and the Institution Decisions, Tilfors uses the triggering of a step-up as a determination of a risk of loss that a trade is an attempt to game the system. Determining risk in this manner allows Tilfors to quickly calculate (1) the risk of a trade by looking at whether the volume of the trade triggers a step-up and (2) the aggregate risk by simply counting the number of times step-up is consecutively triggered at the same price. A0209, 4:53-62; A0210, 6:51-53. In other words, Tilfors counts the number of consecutive times step-up is triggered at the same price to determine the aggregate risk that a trader may be attempting to game the system. A0209, 4:53-62; A0240, ¶ 51; A0243, ¶ 54; A0301, ¶ 48; A0303, ¶ 51. This aggregate risk is compared to a risk threshold, which is the maximum number of consecutive times the market maker allows a step-up to add volume at the same price. If the aggregate risk exceeds the market maker's risk threshold, Tilfors manages the market maker's risk by using tick-worse in place of step-up to add volume in the market maker's quote at the tick-worse price. A0209, 4:53-62; A0240, ¶ 51; A0243, ¶ 54; A0301, ¶ 48; A0303, ¶ 51.

Thus, Tilfors calculates the "risk level" as a value of 1 if the trade triggers a step-up, with each subsequent instance of a consecutive step-up at the same price

representing another increase in "aggregate risk" that a trader is trying to game the system. A0240, ¶ 51; A0243, ¶ 54; A0301, ¶ 48; A0303, ¶ 51. Tilfors thus calculates the "aggregate risk level" that a particular trade is an attempt by a trader to game the system by counting the number of consecutive times step-up is triggered at the same price. A0240, ¶ 51; A0243, ¶ 54; A0301, ¶ 48; A0303, ¶ 51. Indeed, the specifications of the '498 and '457 Patents explicitly state that the aggregate risk can be "calculated" simply by counting. A0177, 14:19-22. Therefore, Tilfors discloses "calculating" a risk level and an aggregate risk level.

Even supposing that Tilfors does not disclose "calculating" a risk level and an aggregate risk level, Tilfors still discloses "measuring" or "otherwise obtaining" these risk levels, which are alternatives to "calculating" in the Board's constructions. Because Tilfors uses the triggering of step-ups as increasing the risk that a trader is trying to game the system, Tilfors "measures" or "otherwise obtains" a specific risk value of "1" for trades by looking at whether the trade triggers a step-up. Likewise, Tilfors "measures" or "otherwise obtains" a specific aggregate risk value by keeping a running count of the measured or obtained risk values from consecutively triggered step-ups. Therefore, Tilfors discloses "measuring" or "otherwise obtaining" a risk level and an aggregate risk level, fully satisfying the Board's constructions of these terms.

IV. Tilfors Discloses "Determining a Specific 'Risk Level' Value, '1,'" for Each Trade Triggering a Step-up

There is no substantial evidence to support the Board's conclusion that Tilfors fails to disclose "determining a specific 'risk level' value, '1,'" for each trade triggering a step-up. In the Final Decisions, the Board concluded without any rationale or support that Tilfors fails to disclose "determining a specific 'risk level' value, '1'" for each trade. A0014; A0034. The Board's conclusion appears to stem from its modified claim constructions and its erroneous belief that because Tilfors does not require calculation of *all kinds* of risks—or at least particular kinds of risks—it does not calculate a "risk level" at all. But it does not matter that Tilfors does not manage all, or particular, types of risks. Tilfors calculates risks to a marker maker when automatically adding volume to her quotes and calculates risk levels by using the triggering of step-up as an indication that a trader is attempting to game the system. A0209, 4:53-62.

In leading up to its conclusion, the Board cited to the following discussion during trial where ISE's attorney explained that Tilfors determines a value of "1" for risk level every time a trade triggers a step-up:

> JUDGE ARBES: But, counsel, where does Tilfors disclose determining a value? I understand what you're showing in the example here, but where exactly does Tilfors say determining that specific value, that specific number?
>
> MR. MURRAY: Because you're counting, you're tracking and counting the number of step-ups. That's clear from the Tilfors

> disclosure. So, that's a value. The number of times you've stepped up is a value. It's one, it's two, it's three, it's four. Those are values.

A1209:20–A1210:2 (cited in A0014; A0034). The Board appears to have rejected this explanation because it believed that the "risk level" needed to be some other kind of value that is calculated using its new requirement of "critical information." Although not expressly stated, it appears the Board was looking for some more complex calculation of a risk value, rather than the simple counting method of Tilfors. But the claims of the '498 and '457 Patents are not so limiting and the specifications explicitly provide that the risk value can be calculated by a simple counting method. A0177, 14:19-22.

As explained above, Tilfors determines the risk that a trader is attempting to game the system (and increasing the risk of loss by the market maker) by counting each consecutive trade that triggers a step-up at the same price. Tilfors executes this counting algorithm after each trade to determine the risk associated with that trade. A0208, 2:39-40. The count of 1 for each new consecutive step-up triggered by a trade is a specific value and the aggregate number of consecutive step-ups is a specific value, whether it is 0, 1, 2, or some other value. A0240, ¶ 51; A0243, ¶ 54; A0301, ¶ 48; A0303, ¶ 51.

The Board also appears to have rejected ISE's explanation of Tilfors' risk level because each trade triggering a step-up is given the same risk level value of "1" regardless of the exact volume of the trade. A0014; A0034-35. The Board's

rejection of Tilfors' disclosure is clearly due to the Board's misunderstanding of the risk of loss that Tilfors is measuring. Tilfors is concerned with the risk of loss that a trader may be gaming the system by using multiple consecutive small orders to buy a large volume of options at the same price. A0209, 4:58-62. Left unchecked, the market maker's risk of loss would be unlimited. After each of these small trades by the trader, the exchange would continuously add more volume to the market maker's quote at the same price. To prevent this unlimited loss from the gaming of the system, Tilfors does not need to use the exact volume of the trade. Rather, Tilfors uses the triggering of a step-up as a determination that a trader may be attempting to game the system. A0209, 4:53-62. After a certain number of consecutive step-ups (the risk threshold previously set by the market maker) the system modifies the market maker's existing quote by adding volume at the tick-worse price (also previously set by the market maker). A0209, 4:53-62.

V. Even Under the Board's Modified Constructions, Tilfors Discloses "Determining a Risk Level and an Aggregate Risk Level Associated with said Trade"

A. Tilfors' Calculation of "Risk Level" and "Aggregate Risk Level" Takes into Account the Board's "Critical Information"

Even under the Board's modified constructions, Tilfors discloses "determining a risk level and an aggregate risk level associated with said trade." The Board's modified constructions require both "risk level" and "aggregate risk level" to be calculated by "taking into account critical information, such as volume

traded, volume remaining in the market-marker's quote, price of the trade, etc." A0014; A0034. Tilfors does all of that.

First, contrary to the Board's assertion that Tilfors "does not take into account the volume added to a market maker's quote when a step-up is triggered by an executed trade," A0016; A0036, Tilfors explicitly takes into account the "volume" type of "critical information" listed by the Board. For each trade, Tilfors takes into account: (1) the volume remaining in the market maker's quote after a trade, (2) the minimum volume X required by the exchange, and (3) the volume required to be added to the quote (the difference between (2) and (1)). A0209, 4:47-53. When a trade is made, Tilfors compares the volume remaining in the market marker's quote to the minimum volume X required by the exchange. A0209, 4:47-53. If the volume remaining in the quote is a little smaller than X, Tilfors uses a step-up to add the required volume. A0209, 4:47-50; A0210, 6:45-48. If the volume remaining in the quote is more than a little smaller than X, Tilfors uses a tick-worse to add the required volume. A0209, 4:50-53; A0210, 6:48-51. Since Tilfors only determines a trade as increasing the risk of gaming the system if the trade triggers a consecutive step-up, a risk level for a trade is determined to be "1" if and only if the trade reduces the volume remaining in the market maker's quote to an amount that is "a little smaller than X." Volume associated with the trade is explicitly part of Tilfors risk management process.

Second, Tilfors' risk management algorithm expressly takes into account the "price" type of "critical information" newly required by the Board. Specifically, the algorithm takes into account (1) the price of the current trade, (2) the price of the prior trade, and (3) whether the prior trade triggered a step-up at the same price. A0209, 4:53-58; A0210, 6:51-53. Tilfors only determines a trade triggering a step-up to be a "consecutive" trade that increases the risk of gaming the system (1) if the price of the current trade is the same as the price of the prior trade; and (2) if the prior trade also triggered a step-up. If the above conditions are met, the current trade is considered a consecutive trade and the risk level of the trade is accumulated to determine the "aggregate risk level." A0209, 4:53-58; A0210, 6:51-53. The price associated with the trade (and the previous trade and the volume added) is explicitly part of Tilfors risk management process.

Thus, Tilfors discloses "determining a risk level and an aggregate risk level associated with said trade" under the Board's modification constructions that require the risk level and the aggregate risk level take into account "critical information" such as volume and price.

B. The Board's Contrary Conclusion Is Not Supported By Substantial Evidence

There is no substantial evidence to support the Board's conclusion that Tilfors fails to disclose "determining a risk level and an aggregate risk level associated with said trade." Nothing in the cited testimony of CBOE's witness, Dr.

Benn Steil, supports that conclusion. Nor do the examples relied upon by the Board, which merely serve to demonstrate the Board's misunderstanding of the Tilfors reference. Finally, the testimony provided by ISE's expert witness was more than sufficient to demonstrate anticipation, and the Board's rejection of her testimony was prejudicial error.

1) Dr. Steil's declaration does not support the Board's conclusion.

The Board cited to the declaration of Dr. Steil, CBOE's witness, only twice in its Final Decisions. A0016, 0018; A0036, 0038. But neither citation rebuts the fact that Tilfors discloses the claimed limitation.

First, the Board cited to Dr. Steil's conclusory statement that "no risk level (*i.e.*, value) is ever determined in Tilfors." A0016; A0036; A0507, ¶ 60; A0575, ¶ 52. Dr. Steil argued in his declaration that whether or not a trade triggers a step-up is "clearly not a *value* of anything, and is certainly not a 'value of exposure to the possibility of loss related to said trade.'" A0507, ¶ 59; A0574, ¶ 51 (emphasis in original). Dr. Steil's testimony simply defies common sense. As explained *supra* in Section IV, the number of step-ups triggered by trades is certainly a value that measures the market maker's risk of loss. Further, as described above, a step-up is a process by which the exchange automatically adds contracts – an obligation to buy or sell options – to a market maker's quote at the current price. For example, if the exchange minimum (X) is 50 contracts, and the step-up triggered as the result

of a trade causes the exchange to automatically add 10 new contracts to the market maker's quote, it strains credulity to state that the step-up is not a "value of exposure to the possibility of loss related to said trade." Because of the trade and the resulting step-up, the market maker is now potentially obligated to buy or sell an additional 10 new option contracts (if a matching order appears in the system) that she wasn't obligated to buy or sell prior to the execution of the trade and the automatic addition of these contracts by the exchange. Further, in the embodiment of Tilfors relied upon, a step-up triggered by a trade is a "value of exposure to the possibility of loss" in that it is a measure that a trader might be trying to game the system through his small order that triggered the step-up. *See supra* Section IV.

Second, the Board cited to Dr. Steil's declaration for the proposition that if Tilfors does not disclose determining a "*value of exposure* to the possibility of loss," then Tilfors does not disclose determining an "*aggregate value* of exposure to the possibility of loss." A0017-18; A0037-38 (emphasis in original); A0509-12, ¶¶ 63-68; A0576-79, ¶¶ 55-60. But as explained consistently by Dr. O'Hara, as the number of measured step-ups increases, the marker maker's risk of exposure to loss increases. A0240, ¶ 51; A0243, ¶ 54; A0301, ¶ 48; A0303, ¶ 51. The aggregate value of exposure (aggregate risk level) is simply calculated by counting the number of consecutive step-ups (a value). The number of step-ups triggered by consecutive trades at the same price, whether it is 0, 1, 2, 3 or some other number,

is unquestionably a value. Again, in the embodiment relied upon, Tilfors uses this number of consecutive step-ups as the "aggregate value of exposure to the possibility of loss" that a trader is trying to game the system through multiple small orders. The market maker had previously determined that after a certain number of step-ups (her risk threshold) she is convinced that the trader is trying to game the system. *See supra* Section IV.

2) The Board's examples do not support the Board's conclusion

The Board's misunderstanding regarding Tilfors' disclosures is clear from the examples the Board used in the Final Decisions. The Board relied on three examples that are not consistent with Tilfors' disclosure. In all three examples, the Board states that the minimum volume X required by the exchange is 100 options.

In the first example used by the Board, the market maker has 101 options in the quote and a trade for 2 options is executed. A0015; A0035. The volume of the quote after the trade is 99, and a step-up is triggered to add 1 option to the quote at the current price. The risk level of the trade is "1" because the trade triggered a step-up. A0015; A0035.

In the second example, the market maker has 200 options in the quote and a trade for 101 options is executed. A0015; A0035. The volume of the quote after the trade is 99, and a step-up is triggered to add 1 option to the quote at the current

price. The risk level of the trade again is "1" because the trade triggered a step-up. A0015; A0035.

The Board pointed to these two examples as demonstrating that Tilfors' "risk level" of "1" does not take into account the volume of the executed trade. A0015; A0035. The Board's argument clearly demonstrates the Board's misunderstanding of the embodiment of Tilfors relied upon by ISE.

First, in this embodiment of risk management, Tilfors does not need to take into account the exact volume of the executed trade that triggered the step-up. Rather, the risk that Tilfors is measuring is the risk that a trader may be trying to game the system by placing multiple orders (triggering multiple step-ups) instead of a single larger order (which would trigger a tick-worse at a worse price). A0209, 4:58-62. To determine the value of this risk, Tilfors assigns a risk level to each consecutive step-up, keeps a running count of the number of step-ups (the aggregate risk level), and when the aggregate risk level exceeds the market maker's risk threshold (the number of consecutive step-ups where the market maker is convinced the trader is gaming the system), the market maker's predefined instructions tell the exchange to add the additional volume at the worse price. A0209, 4:53-62.

Second, in the example where the quote has 200 option contracts, 100 contracts above the exchange minimum of 100 are traded. This embodiment of

Tilfors does not take into account the fact that 100 options above the minimum volume X traded, and the reason is evident; those 100 options will not be automatically added back into the quote by the system. The market maker has already determined her risk associated with those 100 options when she decided to offer 100 options above the exchange minimum.[3] The risk being measured in the Tilfors embodiment relied on is the risk associated with the new volume automatically added by the system when a step-up occurs.

Again, in the embodiment relied upon by ISE, Tilfors manages the risks of a market maker when the volume of a quote drops below the minimum volume X and the system will automatically add additional volume to the quote. A0209, 4:46-62. And under both the original claim constructions and the narrower claim constructions adopted by the Board in the Final Decisions, this embodiment of Tilfors anticipates the independent claims of the ’498 and ’457 Patents. It is irrelevant that there may be other type of risks associated with a trade that this embodiment of Tilfors does not manage. The claims were drafted broadly and this embodiment of Tilfors reads on those claims.

The Board’s third example further illustrates the Board’s misunderstanding of this embodiment of Tilfors. In this example, the market maker has 101 options

[3] Tilfors discloses other embodiments, not relied upon, to manage the risk of a market maker when those 100 options are traded. A0209, 3:5-12; A0210, 5:55-6:2.

in the quote and a trade for 100 options is executed, leaving just 1 option in the quote. A0015; A0035-36. According to the Board, Tilfors would respond to this example by (1) triggering a step-up to add 99 options to the quote at the current price, and (2) determining a risk level of 1 for the trade. A0015-16; A0036.

Contrary to the Board's erroneous assumption, Tilfors would absolutely not respond by triggering a step-up for 99 options when the exchange minimum is 100. Tilfors is quite clear that a step-up is triggered only if the volume remaining in the quote is "only a little smaller than [X] the volume required by the exchange." A0209, 4:47-50. Although Tilfors does not give any numerical examples, it is unreasonable to interpret a volume of 1 option remaining in the quote be considered "only a little smaller than" 100, the minimum volume X in the Board's example. Rather than triggering a step-up, Tilfors expressly explains that "[i]f, on the other hand, a larger volume needs to be generated in order to obtain the volume X, the one tick worse parameter is used to generate the requested volume at a worse price." A0209, 4:50-53. Unquestionably, Tilfors would respond to the Board's third example by triggering a tick-worse to add 99 options to the quote at a worse price.

3) Dr. O'Hara provided credible testimony that Tilfors discloses "determining a risk level and an aggregate risk level associated with said trade"

ISE's witness, Dr. O'Hara, provided credible testimony that Tilfors discloses "determining a risk level and an aggregate risk level associated with said trade." As testified by Dr. O'Hara, Tilfors determines a "risk level" by looking at whether a trade triggers a step-up, and determines an "aggregate risk level" by counting the number of times step-up is triggered consecutively at the same price. In her declaration, Dr. O'Hara testified that Tilfors "examines the risk level by looking at whether or not a trade triggers a step up." A0240, ¶ 51; A0301, ¶ 48. She also testified that Tilfors "determines risk level and aggregate risk level by looking at whether or not a trade triggers a step up and how many times a step up has been triggered." A0243, ¶ 54; A0303, ¶ 51.

During her deposition, Dr. O'Hara again testified that Tilfors determines a "risk level" and an "aggregate risk level" in the above manner. For example, Dr. O'Hara testified that Tilfors "determines risk level and aggregate risk levels by looking at whether or not a trade triggers a step up and how many times a step up has been triggered, so a risk level can be the fact that we're stepping up and the aggregate risk level is how many times we've done it." A0797:4-10.

Despite Dr. O'Hara's clear and consistent testimony regarding disclosures of Tilfors, the Board erred by crediting CBOE's attorney arguments that Dr. O'Hara

was unable to explain how Tilfors discloses the "risk level" and "aggregate risk level" of the '498 and '457 Patents. A0016-18; A0036-38.

The Board pointed to an excerpt of Dr. O'Hara's deposition testimony after she explained that Tilfors determines a "risk level" by looking at whether or not a trade triggers a step-up. A0016; A0036. Following her explanation, CBOE's attorney asked, "So the risk level is the fact that we're stepping up?" A0798:5-6. Perceiving that there may be some confusion as to how and why Tilfors determines "risk level" in this manner, Dr. O'Hara responded by stating, "That is kind of strange, right?" A0798:7. The Board took this professorial statement to mean that Dr. O'Hara could not articulate how Tilfors determines a "risk level." A0016; A0036. This is not true.

Dr. O'Hara clearly explained in her declaration and during her deposition that Tilfors uses the triggering of a step-up to determine the "risk level." Immediately following her "strange" comment, Dr. O'Hara once again explained that Tilfors makes such risk level determinations so that when the aggregate risk level has reached a certain point, Tilfors can respond in a pre-specified manner (using tick-worse in place of step-up) to manage the market maker's risks. A0798:8-14.

The Board further pointed to Dr. O'Hara's testimony that one of the risks that a market maker faces in trading is opportunity-lost risk, *i.e.*, "not having a

quote that can be hit by people who want to trade." A0016-17; A0037; A0704:21-23. The Board then credited CBOE's attorney argument that by making this statement Dr. O'Hara was somehow testifying that a "risk level" in Tilfors could be increased by trades that do not trigger a step-up. The Board proceeded to discredited Dr. O'Hara's testimony because Tilfors does not keep track of opportunity-lost risk because it does not increase the volume in the market maker's quote. A0016-17; A0037. This is a red herring argument.

Firstly, Dr. O'Hara never testified that the "risk level" in Tilfors could be increased by a trade that does not trigger a step-up. When Dr. O'Hara mentioned the opportunity-lost risks faced by market makers, she was not discussing the "risk level" of the '498 and '457 Patents. Instead, she was referring to one of the purposes of Tilfors' automatic risk management, which is to promote liquidity and reduce market makers' opportunity-lost risks by allowing market makers to automatically add volume to the market makers' quotes when the volume drops below the minimum volume X. *See supra* Section I.D. In fact, Dr. O'Hara expressly distinguished her testimony regarding opportunity-lost risks as being separate and different from her testimony regarding Tilfors' disclosure of "risk level." A0816:6-20.

Secondly, it makes no sense to require Tilfors to keep track of opportunity-lost risks when the '498 and '457 Patents do not keep track of such risks. As stated

clearly in the independent claims, the ’498 and ’457 Patents determines “risk level” and “aggregate risk level” only when a trade is made. Nowhere does the ’498 and ’457 Patents claim the use of opportunity-lost risks.

The Board also pointed to Dr. O’Hara’s deposition testimony to imply that she testified that Tilfors does not teach “aggregate risk level.” A0018; A0038. The relevant exchange is provided below:

> Q. Where in Tilfors does it ***expressly*** describe the aggregate risk level?
>
> A. I'm not sure that it does. I could go through and see if it ***uses the word “aggregate,”*** but I think Tilfors, Tilfors is just giving you a broad measure of risk, it just -- this is your -- a broad exposure to what’s happening to you in your trading, it’s -- like I said, it’s a broad measure.

A0773:11-19 (emphasis added). It is clear from this exchange that Dr. O’Hara was testifying that she was not sure if Tilfors “expressly” uses the word “aggregate,” not that Tilfors did not teach the claimed concept of an aggregate risk level. Indeed, shortly following the above exchange, Dr. O’Hara again explained that Tilfors determines “aggregate risk” by counting the number of trades that trigger step-ups:

> The step-up procedure is keeping track of how many times you have traded at a particular quote and the volume has been stepped up, so it’s giving you an indication of your **aggregate** risk level, that you’ve been, for example, trading – you’ve been buying, buying, buying, buying, and that’s keeping track of the aggregate risk you have in this contract and it is then adjusting your prices when it decides to tick worse to protect you.

A0775:3-12 (emphasis added).

The Board additionally pointed to Dr. O'Hara's testimony that the value of the risk level and aggregate risk level can be the same to discredit her testimony. A0018, A0038. When asked if the risk level and the aggregate risk level can be the same, Dr. O'Hara responded, "They can be. I don't know that they have to be, but they can be the same." A0790:13-17. This is not a controversial statement but a mere truism. When the first step-up in Tilfors is counted, the risk level is 1 and the aggregate risk level is 1. Indeed, even CBOE's own expert admitted that the risk level and the aggregate risk level can be the same. A1057:23-A1058:23.

The Board erred by crediting CBOE's argument that Dr. O'Hara had "admitted that, in Tilfors, it may be impossible to distinguish between a 'risk level' and an 'aggregate risk level.'" A0018; A0038; A0413; A0470-71. Simply stating that the value of the risk level and aggregate risk level can be the same is not stating that it is impossible to distinguish between the different risk levels.

VI. The Board's Decision on Dependent Claims of the '498 Patent Is Entirely Dependent on Its Erroneous Finding That Tilfors Does Not Anticipate the Independent Claims

The Board did not separately address how the prior art renders the dependent claims 9, 11, 14, 15, and 23 of the '498 Patent obvious. Based on its flawed finding that Tilfors does not anticipate the independent claims of the '498 Patent, the Board concluded that the dependent claims are not invalid as obvious over Tilfors and another prior art reference. A0018-19. Because Tilfors anticipates the

independent claims of the ’498 Patent, the Board erred in holding that the dependent claims are not obvious in view of the prior art.

CONCLUSION AND STATEMENT OF RELIEF SOUGHT

The Board erred in concluding that Tilfors does not disclose “determining a risk level and an aggregate risk level associated with said trade.” The Board committed legal error by modifying its original constructions of “risk level” and “aggregate risk level” using a standard other than the broadest reasonable interpretation standard. Even under the Board’s modified, impermissibly narrow constructions, Tilfors discloses “determining a risk level and an aggregate risk level associated with said trade.” Therefore, this Court should reverse the decisions below and remand for consideration of the invalidity of claims 1, 8, 9, 11, 14, 15, and 23 of the ’498 Patent and claim 1 of the ’457 Patent.

Respectfully submitted,

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ADDENDUM

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Paper 39
Date: March 2, 2015

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

INTERNATIONAL SECURITIES EXCHANGE, LLC,
Petitioner,

v.

CHICAGO BOARD OPTIONS EXCHANGE, INC.,
Patent Owner.

Case IPR2014-00097
Patent 7,356,498 B2

Before JUSTIN T. ARBES, RAMA G. ELLURU, and JAMES B. ARPIN, *Administrative Patent Judges.*

ELLURU, *Administrative Patent Judge.*

FINAL WRITTEN DECISION
35 U.S.C. § 318(a) and 37 C.F.R. § 42.73

I. BACKGROUND

Petitioner, International Securities Exchange, LLC, filed a Petition (Paper 1, "Pet.") requesting *inter partes* review of claims 1–28 of U.S. Patent No. 7,356,498 B2 (Ex. 1001; "the '498 patent"). Patent Owner, Chicago Board Options Exchange, Inc., filed a Preliminary Response opposing institution of review (Paper 9; "Prelim. Resp."). On May 22, 2014, we instituted an *inter partes* review of claims 1, 8, 9, 11, 14, 15, and 23 of the '498 patent (Paper 12; "Dec. on Inst.").

Subsequent to institution, Patent Owner filed a Patent Owner Response (Paper 26; "PO Resp."), and Petitioner filed a Reply (Paper 31; "Pet. Reply").

We held an oral hearing on January 21, 2014, and a transcript of the hearing is included in the record (Paper 38; "Tr.").

We have jurisdiction under 35 U.S.C. § 6(c). This Final Written Decision is issued pursuant to 35 U.S.C. § 318(a) and 37 C.F.R. § 42.73.

For the reasons that follow, we determine that Petitioner has not shown by a preponderance of the evidence that claims 1, 8, 9, 11, 14, 15, and 23 of the '498 patent are unpatentable based on the instituted grounds in this *inter partes* review.

A. The '498 Patent

The '498 patent, titled "Automated Trading Exchange System Having Integrated Quote Risk Monitoring and Integrated Quote Modification Services," issued on April 8, 2008, based on U.S. Patent Application No. 09/475,534 ("the '534 application"),[1] filed on December 30, 1999.

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[1] U.S. Patent Application No. 12/035,996 is a continuation of the '534 application, and issued as U.S. Patent No. 7,980,457 B2 ("the '457 patent"). U.S. Patent Application No. 13/178,289 ("the '289 application") is a continuation of the '996 application and issued as U.S. Patent No. 8,266,044 B2 ("the '044 patent"). The '498 patent is the subject of CBM2013-00049. The '457 patent is also the subject of CBM2013-00050 and IPR2014-00098. The '044 patent is the subject of

The ’498 patent relates to automated trading systems for option contracts (“options”). Ex. 1001, 1:8–12, Abstract. Specifically, the claimed invention is directed to methods for managing the risk of a maker of an options market in an automated trading system. *Id*. at 1:8–12.

Options are traded publicly on exchanges. *Id*. at 1:17. Each option covers certain rights to buy or sell an underlying security at a fixed price for a specified period of time. *Id*. at 1:18–21. The potential loss to the buyer of an option is no greater than the initial premium paid for the option, regardless of the performance of the underlying security. *Id*. at 1:27–29. On the contrary, in exchange for the premium, the seller of the option (“the market-maker”) assumes the risk of being assigned the obligation to buy or sell the underlying security, according to the option terms, if the contract is exercised. *Id*. at 1:30–34. Thus, writing options may entail large risks to the market-maker. *Id*. at 1:34–35.

Many option trading systems utilize an “open outcry” method. *Id*. at 1:43–44. In such systems, market-makers are required to make a two-sided market by providing an order and an offer quote. *Id*. at 1:44–46. In a non-automated open outcry system, a market-maker communicates verbally with traders indicating their willingness to buy and sell various quantities of securities. *Id*. at 1:46–49. Because a market-maker in such systems has personal control over the types and number of options traded, the market-maker can manage risk associated with his or her options portfolio. *Id*. at 1:49–53. A market-maker manages risk by adjusting quotes for options to favor trades that tend to hedge against unwanted risk. *Id*. at 1:52–55.

The ’498 patent Specification states that an automated trading environment

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CBM2013-00051. Final Written Decisions also are entered in these cases concurrently with this Decision.

already was known in the art. *Id*. at 1:56–58, 61–65. An automated, computer-based trading system typically records quotes and automatically matches them with orders that enter the system. *Id*. at 1:58–61. One disadvantage of known automated trading systems is that the systems execute trades so rapidly that a market-maker may be unable to withdraw or modify his quotes in a timely manner. *Id*. at 1:61–2:5. Software tools that assess trading option portfolio risk and recommend quote modifications also were known. *Id*. at 2:6–12. An automated trading system, however, processes transactions in the order received. *Id*. at 2:16–19. Thus, even if a market-maker uses such software tools to modify quotes, those tools may be unable to act in time, given the speed at which the automated trading exchange system executes orders. *Id*. at 2:12–16. For example, an automated trading exchange may have a message queue containing additional orders that must be processed before the automated exchange receives and processes the market-maker's quote modification request. *Id*. at 2:19–23. These known, automated trading exchange systems, therefore, limit a market-maker's ability to manage risk. *Id*. at 2:24–32. The '498 patent Specification recognizes the need for a method that automatically modifies quotes under certain trading conditions in an automated trading exchange system. *Id*. at 2:33–35.

The invention of the '498 patent is directed to methods for modifying quotes in an automated exchange trading system, where the system provides integrated quote risk monitoring and quote modification services. *Id*. at 2:39–41. Thus, one aspect of the invention is an apparatus that implements the method using a computer, having memory, a processor, and a communication port. *Id*. at 2:41–44.

The computer receives orders and quotes, wherein a quote has associated trading parameters, such as a risk threshold. *Id*. at 2:44–47. The computer then may generate a trade by matching the received orders and quotes to previously

received orders and quotes. *Id*. at 2:54–56. If a trade is not generated, the computer stores each of the received orders and quotes. *Id*. at 2:56–57. The computer determines whether a market-maker's quote has been filled as a result of the generated trade, and, if so, determines a risk level and aggregate risk level associated with the trade. *Id*. at 2:57–61. The computer then compares the aggregate risk level with the market-maker's risk threshold for a quote; if the threshold is exceeded, the computer automatically modifies at least one of the market-maker's remaining quotes. *Id*. at 2:61–64.

B. Illustrative Claim

Of the challenged claims, claims 1 and 8 are independent claims. Claim 1 of the '498 patent, reproduced below, is illustrative of the challenged claims.

1. A method of modifying quotes in an automated exchange trading system comprising the steps of:

receiving orders and quotes, wherein specified ones of said quotes belong to a quote group, and wherein said specified ones of said quotes have associated trading parameters comprising a risk threshold;

generating a trade by matching said received orders and quotes to previously received orders and quotes;

storing each of said orders and quotes when a trade is not generated;

determining whether a quote having associated trading parameters has been filled as a result of the generated trade, and if so, determining a risk level and an aggregate risk level associated with said trade;

comparing said aggregate risk level with said risk threshold; and, automatically modifying at least one of the remaining said specified ones of said quotes in the quote group if said threshold is exceeded.

C. Prior Art

The pending grounds of unpatentability in this *inter partes* review are based on the following prior art.

Patent/Publication No.	Date of Issuance or Publication	Exhibit No.
U.S. Patent No. 6,405,180 B2 ("Tilfors")	June 11, 2002	Ex. 1002
Allen Jan Baird, *Option Market Making, Trading and Risk Analysis for the Financial and Commodity Options Markets*, (1993) ("Baird")	1993	Ex. 1003

Petitioner also relies upon the Declaration of Dr. Maureen O'Hara. Ex. 1004.

D. Pending Grounds of Unpatentability

We instituted an *inter partes* review of the '498 patent based on the following grounds:

1. Claims 1 and 8 as anticipated under 35 U.S.C. § 102(e) by Tilfors; and
2. Claims 9, 11, 14, 15, and 23 as unpatentable under 35 U.S.C. § 103(a) over Tilfors and Baird.

Dec. on Inst. 27.

II. ANALYSIS

A. Claim Construction

Consistent with the statute and the legislative history of the AIA,[2] the Board will interpret claims using the broadest reasonable construction in light of the specification of the challenged patent. *See Office Patent Trial Practice Guide*, 77 Fed. Reg. 48,756, 48,766 (Aug. 14, 2012); 37 C.F.R. § 42.100(b); *In re Cuozzo Speed Techs., LLC*, No. 2014-1301, 2015 WL 448667, at *5–8 (Fed. Cir. Feb. 4, 2015). There is a "'heavy presumption' that a claim term carries its ordinary and customary meaning." *CCS Fitness, Inc. v. Brunswick Corp.*, 288 F.3d 1359, 1366 (Fed. Cir. 2002) (internal citation omitted).

[2] Leahy-Smith America Invents Act, Pub. L. No. 112-29, 125 Stat. 284 (2011) ("AIA").

In our Decision on Institution, we construed certain claim terms as follows:

Claim Term	Construction
"risk level . . . associated with said trade"	"a calculated, measured, or otherwise obtained value of exposure to the possibility of loss related to said trade"
"aggregate risk level associated with said trade"	"a calculated, measured, or otherwise obtained aggregate value (e.g., combination, sum, weighed sum, difference) of exposure to the possibility of loss related to such trade"
"automatically modifying at least one of the remaining said specified ones of said quotes in the quote group if said threshold is exceeded"	"automatically cancelling or revising a price or quantity of at least one of the received specified quotes still available for execution"

Dec. on Inst. 8–11. Petitioner does not challenge these constructions (Tr. 6:18–7:2), nor does Patent Owner (*id*. at 39:14–15, 40:1–3). We discern no reason to deviate from our constructions in our Decision on Institution for purposes of this Final Written Decision.

B. Anticipation of Claims 1 and 8 by Tilfors

With respect to Petitioner's contention that claims 1 and 8 are anticipated by Tilfors, we have reviewed Petitioner's arguments and the evidence relied upon by Petitioner, and conclude that Petitioner has not established by a preponderance of the evidence that claims 1 and 8 are anticipated by Tilfors. Specifically, Petitioner has not established by a preponderance of the evidence that Tilfors discloses "determining a risk level and an aggregate risk level associated with said trade," as recited by claims 1 and 8.

Petitioner refers predominantly to one passage in Tilfors as disclosing the limitations of claims 1 and 8. *See* Pet. 23, 25, 28–31, 35, 37–38 (citing Ex. 1002,

4:45–63); Pet. Reply 2 (citing Ex. 1002, 4:46–62); Tr. 8:4–22, 18:19–25. The relied-upon passage provides the following:

> However, in a preferred embodiment, the step 211 can be executed in the following manner (not shown). If the total volume is only a little smaller than the volume required by the exchange, the step up parameter is used to automatically generate more volume at the current price. If, on the other hand, a larger volume needs to be generated in order to obtain the volume X, the one tick worse parameter is used to generate the requested volume at a worse price. Also, if in the step 211, the step up parameter has been used to generate more volume a number of consecutive times at the same price, the one tick worse parameter can be used, even though the step-up parameter normally should have been used. This will prevent that a customer enters a large number of small orders and that the system then generates more volume at the current price instead of offering a worse price as would have been the case if the customer had entered one large order.

Ex. 1002, 4:46–62. Petitioner explains that Tilfors's "step up functionality allows a partially filled quote to be automatically modified by increasing the volume in the quote to a predetermined level set by the market maker or the exchange." Pet. 19–20. Petitioner provides the following example—if the market-maker's original quote was for 50 option contracts, and the market-maker trades against an order for 20 contracts, 30 contracts remain in the quote. *Id*. The step-up function automatically modifies the quote to increase the volume back up to the predetermined level ("X"), which could be, for example, 50 contracts. *Id*.; *see* Ex. 1002, 4:37–41 ("X is a parameter predefined by the exchange").

Petitioner maintains that when Tilfors executes trades, risk level and aggregate risk level are tracked. Pet. 23. According to Petitioner, "[e]ach trade against a quote, and implementation of the step up function, carries with it an inherent risk level as volume is added." *Id*. (citing Ex. 1004 ¶ 51). Petitioner further contends that "Tilfors counts the number of step ups applied against a

quote, thus determining an 'aggregate risk level.'" *Id*. (citing Ex. 1002, 4:45–63, 6:45–54). Petitioner argues that the recited "risk threshold" "reads directly on the programmed *number of times* the step up parameter is permitted to generate more volume at the same prices before invoking tick worse." *Id*. (citations omitted; emphasis added). With respect to the "modifying" limitation of claims 1 and 8, Petitioner asserts that "[w]hen the step up count threshold is exceeded, tick worse is invoked, which regenerates the quote at a worse price," which according to Petitioner, is "something the '498 patent makes clear is one of the ways a quote can be modified in response to exceeding a risk threshold." *Id*. (citations omitted).

In our Decision on Institution, based on the record then before us, we instituted a review based on the following determinations.

> [W]hether or not a trade triggers a step-up in volume is a calculation of the market maker's exposure to the possibility of loss related to a trade, i.e., the claimed "*risk level*." Ex. 1004 ¶ 51.

Dec. on Inst. 13. We further agreed with Petitioner that the number of step-ups, i.e., volume increases, applied against a quote, satisfies the recited "aggregate risk level." *Id*. at 13–14. We also determined that because a tick worse parameter is applied if a step-up has been triggered a pre-defined number of times, Petitioner had made a sufficient showing that Tilfors discloses "automatically modifying at least one of the remaining said specified ones of said quotes in the quote group if said threshold is exceeded," as recited by claim 1, and "automatically modifying at least one of the specified ones of received quotes if said threshold is exceeded," as recited by claim 8. *Id*. at 14.

Patent Owner disagrees that Tilfors discloses "determining a risk level . . . associated with said trade." PO Resp. 32–36. Specifically, Patent Owner argues that "whether or not a trade triggers a step-up" does not

satisfy the recited "risk level . . . associated with said trade," which we interpreted as "a calculated, measured, or otherwise obtained *value of exposure to the possibility of loss related to said trade*." *Id*. at 33 (emphasis added); *see* Dec. on Inst. 8–9. According to Patent Owner, whether or not a trade triggers a step-up is merely a decision to maintain the exchange-required minimum volume and "is clearly not a value of anything." PO Resp. 33. Patent Owner asserts that "whether or not a step-up is triggered is merely a yes-or-no question about exchange volume with only a yes-or-no answer." *Id*. Thus, argues Patent Owner, the decision to step-up is not "a calculated, measured, or otherwise obtained *value of exposure*, but rather a determination to fulfill an exchange requirement." *Id*. at 33–34 (emphasis in original).

In its Reply, with respect to the recited "risk level . . . associated with said trade," Petitioner argues that "[e]ach step-up represents the addition of volume to a quote, and volume is a risk level." Pet. Reply 7. Thus, according to Petitioner, because each step-up represents the addition of volume—volume which could be bought by a trade—the "risk level" is increased. Tr. 20:20–21, 21:14–17, 21:18–22, 22:3–8; *see* Pet. Reply 10–11 (Petitioner's hypothetical presented to Patent Owner's witness, Dr. Benn Steil). Petitioner states that "counting step-ups effectively counts risk levels and creates an aggregate risk level." Pet. Reply 11. Petitioner further argues that Tilfors discloses the recited "aggregate risk level" because it keeps track of the number of times volume is added in the step-up procedure. *Id*. at 7.

In support of its argument, at the oral hearing, Petitioner provided the following example of Tilfors's embodiment.

Example of The Tilfors Process

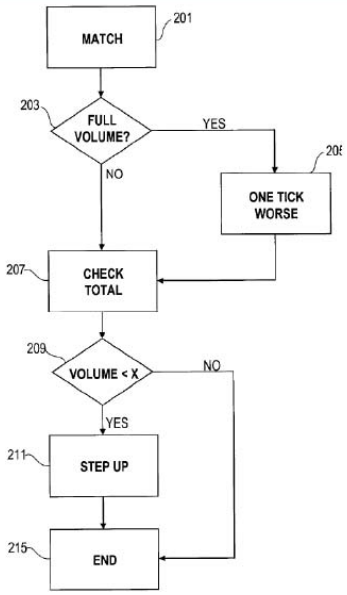

FIG. 2A

Example:
X = 2; Initial Quote = 2; Matching Order = 1
Maximum Number of Step-Ups = 2

On first step-up:
Volume added = 1
Risk = 1
Aggregate risk = 1

On second step-up:
Volume added = 1
Risk = 1
Aggregate risk = 2

Instead of third step-up,
volume of 1 added but at tick worse price

Ex. 1002 (Tilfors) at 4:32-62; *See* Paper No. 34 (Petitioner's Reply in IPR2014-00098) at 13.

ISE's Demonstrative Slides, Ex.1007 (IPR97), Ex. 1010 (IPR98) 14

Ex. 1007, Slide 14 (citing Pet. Reply 13); *see* Tr. 19:6–20:21.[3]

Petitioner confirms that it is relying on the aspect of the embodiment illustrated in Figure 2A, in which less than the full volume of the market-maker's quote is traded consecutively (i.e., the answer is "no" at step 203 and "yes" at step 209) and more volume is generated in the market-maker's existing quote at the same price (step 211). Tr. 18:19–19:2, 26:11–16, 63:20–25; *see* Ex. 1002, 4:37–43. Thus, at least "1" contract remains in the

[3] For purposes of explaining the parties' positions, and ease of reference, we address herein the parties' arguments in the context of the examples discussed at the hearing. The parties' substantive arguments, on which those examples are based, however, are reflected in the parties' papers. *See, e.g.*, Pet. 18–38; PO Resp. 32–36; Pet. Reply 7–11.

market-maker's quote. The other aspect of Tilfors's embodiment provides that if the full volume in the market-maker's quote is traded at Tilfors's step 203 in Figure 2A, the next step is step 205. Petitioner, however, is not relying on this aspect of the embodiment. Tr. 63:17–64:6.

In the hypothetical presented by Petitioner, "X," the minimum volume required by the electronic exchange, is "2" contracts (*id*. at 19:24–25), the predefined number of step-ups (i.e., what we determined at institution is the claimed "risk threshold") is "2" (*id*. at 19:11–15), the market-maker's initial quote is for "2" contracts, and there is a matching order for "1" contract (*id*. at 19:16–17, 20:1–2). According to Petitioner, after the first trade, because the "full volume" of the market-maker's quote was not traded according to step 203 (i.e., one contract still remains in the market-maker's quote), the process proceeds to step 207. *Id*. at 20:5–10. At step 207, the process checks whether the total volume remaining in the market-maker's quote, "1" contract, is less than the "2" contract minimum required by the exchange. *Id*. at 20:10–12. Because the remaining volume in the market-maker's quote is less than X, the minimum required by the exchange, a step-up application is triggered (step 211), whereby volume ("1" contract) is added to the market-maker's quote to satisfy X, at the market-maker's current price. Ex. 1007, Slide 14; Tr. 19:20–20:2; Ex. 1002, 4:47–50. According to Petitioner, "one step-up equals a risk level of one," so the market-maker's risk level after the first trade in the hypothetical is "1" and the claimed "aggregate risk level" is "1." Tr. 20:13–21, 22:16–19. Petitioner further contends that the claimed "risk level" does not depend on the price of the contract traded. *Id*. at 21:18–22:8. Petitioner further argues that the "risk level" is "1" each time

a step-up is applied, and that after applying the step-up functionality twice, the "aggregate risk level" is "2." Ex. 1007, Slide 14.

Petitioner acknowledges that, based on the relied-upon Tilfors embodiment, the volume added to a market-maker's quote during a step-up can be more than "1" contract. Tr. 23:16–24. For example, Petitioner explains that if X is equal to "11," a market-maker knows that every time Tilfors's step-up is applied, the volume added to his quote could be "1" contract "up to 10 contracts." *Id*. at 27:5–10. Petitioner, however, maintains that although any time a trade triggers a step-up, the volume of contracts that can be added could be a range, the "risk level" is "1" "because that represents one increase in volume" and "[h]ow many times you've increased that volume is your aggregate risk value." *Id*. at 28:11–16, 29:6–25. Thus, according to Petitioner, Tilfors discloses that the "risk level" is "1" whenever an executed trade triggers a step-up, regardless of any other information, including the volume of the executed trade and the volume that is added when the step-up is applied to the market-maker's quote. *Id*. at 30:6–24.

> JUDGE ELLURU: So, you're saying the risk value is the same regardless of the number of contracts you're increasing?
>
> Mr. MURRAY: That's right. That's exactly right.

Id. at 31:1–3; 32:19–25, 34:12–16. Although Tilfors's step-up functionality may indicate an increase in risk because it is an indication that volume needs to be added to a market maker's quote, Petitioner has not persuaded us that Tilfors discloses the claimed "risk level"—which the parties do not contest means "a calculated, measured, or otherwise obtained value of exposure to the possibility of loss related to said trade." *See supra* Sec. II.A.

Foremost, Petitioner has not shown sufficiently that Tilfors expressly discloses "determining" a "risk level . . . associated with said trade." *See* Tr. 22:20–23:2. Based on our review of the record, Petitioner has not shown sufficiently that Tilfors describes determining a specific "risk level" value, "1," as asserted by Petitioner. Although Tilfors keeps track of the number of times a market-maker has stepped up (*id*.), we are not persuaded that that disclosure describes determining a "risk level" of "1" for each "such trade." Furthermore, we are not persuaded that under our construction, a "risk level" for a particular trade can be calculated without taking into account critical information, such as volume traded, volume remaining in the market-maker's quote, price of the trade, etc. *See id*. at 40:18–21. As Patent Owner contends, the recited "risk level" is for each "such trade," i.e., "[a] trade that has already taken place." *Id*. at 37:6–9; *see id*. at 40:4–5. Petitioner argues that any trade that triggers a step-up in the relied upon embodiment in Tilfors has a "risk level" of "1." A "risk level" of "1," however, does not take into account the volume that was traded in the executed trade, nor does "1" reflect the amount of volume that may be added by Tilfors's step-up function. Even accepting Petitioner's assertion that Tilfors's step-up is an "indication" of risk because it tells a market-maker that volume has been added to the quote (*id*. at 31:11–14, 65:18–23), and the market-maker is aware of the range of volume that has been added to his quote, (i.e., 1 to X, the minimum number of contracts that must be quoted by the market-maker), *that range*, calculated mentally by the market-maker, would not be represented by a "risk level" of "1." *See id*. at 31:3–14, 37:19–21, 65:13–24.

The absence of a correlation between whether a step-up has been triggered in the relied upon embodiment in Tilfors and our uncontested

interpretation of "risk level" of an executed trade is illustrated by specific examples. Applying the embodiment in Tilfors relied upon by Petitioner, if "X" is "100," and a market-maker has "101" contracts outstanding in the exchange's order book, and "2" contracts are traded, the market-maker's available quote drops to "99" contracts (step 209). *Id*. at 37:22–24. Pursuant to the embodiment described in Tilfors, a step-up function (step 211) would be applied to increase the market-maker's available quote by "1" contract to reach "X." *Id.* at 37:24–35:1; Ex. 1002, Fig. 2A (steps 209 and 211). According to Petitioner's argument, "2" contracts have been traded, and the "risk level" is "1" because one step-up has been triggered. Tr. 38:1–2.

In another example, if "X" is "100," and a market-maker has "200" contracts outstanding in the exchange's order book, and "101" contracts are traded, the market-maker's available quote drops to "99" contracts (step 209). As in the example above, a step-up function (step 211) would be applied to increase the market-maker's available quote by "1" contract to reach "X." Pursuant to Petitioner's argument, "101" contracts have been traded, and the "risk level" is "1" (the same "risk level" as in the preceding example in which "2" contracts were traded) because one step-up has been triggered. This example demonstrates that a "risk level" of "1" does not take into account the volume of the executed trade (i.e., the recited "said trade" in claims 1 and 8). In yet another example, if "X" remains "100," and a market-maker has "101" contracts outstanding in the exchange's order book, and "100" contracts are traded, the market-maker's available quote drops to "1" contract (step 209). Pursuant to the embodiment described in Tilfors, a step-up function (step 211) would be applied to increase the market-maker's

available quote by "99" contracts to reach "X." According to Petitioner's argument, "99" contracts have been added to the market-maker's quote and the "risk level" is "1" (the same "risk level" as in the first example in which "1" contract was added to the market-maker's quote) because one step-up has been triggered. This example demonstrates that a "risk level" of "1" does not take into account the volume added to a market-maker's quote when a step-up is triggered by an executed trade (i.e., the recited "said trade" in claims 1 and 8). In sum, these examples demonstrate to us the indefensible nature of Petitioner's argument.

We also do not find the testimony provided by Petitioner's witness, Dr. Maureen O'Hara, in support of Petitioner's argument to be persuasive. Dr. O'Hara states, for example, "Tilfors/Katz *examines* the risk level by looking at whether or not a trade triggers a step up." Ex. 1004 ¶ 51 (emphasis added); *see* Ex. 2012 at ¶ 60 (Patent Owner's witness testifies that "no risk level (i.e., value) is ever determined in Tilfors"). Dr. O'Hara also testified as follows:

> Q: So the risk level is the fact that we're stepping up?
>
> A: That is kind of strange; right?

Ex. 2013, 187:5–7. Dr. O'Hara did not provide a satisfactory explanation as to how Tilfors discloses the recited step of "determining a risk level . . . associated with said trade."

> Q: I'm just talking about the decision whether or not to step up.
>
> A: So the decision to step up is *related to the market maker's risk*.

Id. at 93:16–19 (emphasis added). In addition, Dr. O'Hara testified that not stepping-up, i.e., not increasing the volume in a market-maker's quote, also represents risk.

> Q: So the measure of risk was what?
>
> A: It was the fact that I had to step up, it was the trade.
>
> . . .
>
> Q: And the [market-maker's] risk is not being in the market?
>
> A: The risk is not having a quote that can be hit by people who want to trade.

Id. at 203:22–24, 93:21–23. As Patent Owner notes (PO Resp. 35–36 n.5), however, when a trade triggers a step-up in volume, which Petitioner contends has a risk level of "1," Tilfors does not keep track of the risk to which Dr. O'Hara refers, i.e., not increasing the volume in a market-maker's quote so that it "can be hit by people who want to trade." Ex. 2013 93:16–23. Thus, we are not persuaded that Dr. O'Hara's testimony supports Petitioner's position that whether an executed trade triggers the application of a step-up in volume in a market-maker's quote discloses the recited "determining a risk level . . . associated with said trade."

In sum, we determine that Petitioner has not demonstrated by a preponderance of the evidence that Tilfors discloses the recited step of "determining a risk level . . . associated with said trade."

Using the same reasoning, Patent Owner also argues that Tilfors fails to disclose the recited step of "determining . . . an aggregate risk level associated with said trade." PO Resp. 36–37. We construed "aggregate risk level associated with said trade" as "a calculated, measured, or otherwise obtained aggregate value (e.g., combination, sum, weighed sum, difference) of exposure to the possibility of loss related to such trade." *See supra* Sec. II.A. Specifically, Patent Owner contends that "[b]ecause Tilfors does not disclose determining a calculated, measured, or otherwise obtained *value of exposure* to the possibility of loss related to said trade, Tilfors . . . does not

disclose determining a calculated, measured, or otherwise obtained *aggregate value* of exposure to the possibility of loss related to such trade." PO Resp. 37 (citing Ex. 2012 ¶¶ 63–68) (emphasis in original). We agree that Petitioner has not shown sufficiently that Tilfors discloses the step of "determining . . . an aggregate risk level associated with said trade."

We further agree with Patent Owner (*id*.) that Dr. O'Hara, Petitioner's witness, does not provide persuasive testimony that Tilfors discloses the recited step of "determining . . . an aggregate risk level associated with said trade." For example, Dr. O'Hara testified as follows.

> Q: Where in Tilfors does it expressly describe the aggregate risk level?
>
> A: I'm not sure that it does. I could go through and see if it uses the word "aggregate," but I think Tilfors, Tilfors is just giving you a broad measure of risk, it just -- this is your -- a broad exposure to what's happening to you in your trading, it's -- like I said, it's a broad measure.

Ex. 2013, 162:11–19. Dr. O'Hara also testified as follows.

> Q: Has your opinion been based on your understanding that the risk level and the aggregate risk level can be the same?
>
> A: They can be. I don't know that they have to be, but they can be the same.

Id. at 179:13–17. Thus, we likewise determine that Petitioner has not demonstrated by a preponderance of the evidence that Tilfors discloses the recited step of "determining . . . an aggregate risk level associated with said trade."

III. DEPENDENT CLAIMS

Petitioner also cannot prevail with respect to its challenge to dependent claims 9, 11, 14, 15, and 23 as obvious over Tilfors and Baird.

Petitioner does not contend that Baird cures the deficiency discussed above with respect to Tilfors. Pet. 40–52. Thus, we determine that Petitioner has not established by a preponderance of the evidence that claims 9, 11, 14, 15, and 23 are unpatentable as obvious pursuant to 35 U.S.C. § 103(a) over Tilfors and Baird.

IV. CONCLUSION

Based on the foregoing, we determine that Petitioner has not established by a preponderance of the evidence that independent claims 1 and 8 are unpatentable as anticipated by Tilfors pursuant to 35 U.S.C. § 102(e), or that dependent claims 9, 11, 14, 15, and 23 are unpatentable as obvious over Tilfors and Baird pursuant to 35 U.S.C. § 103(a).

This Decision constitutes a Final Written Decision under 35 U.S.C. § 318(a).

V. ORDER

In consideration of the foregoing, it is

ORDERED that claims 1, 8, 9, 11, 14, 15, and 23 of the ’498 patent have not been shown to be unpatentable based on the instituted grounds in this *inter partes* review; and

FURTHER ORDERED that either party to this proceeding seeking judicial review of the Decision must comply with the notice and service requirements of 37 C.F.R. § 90.2.

IPR2014-00097
Patent 7,356,498 B2

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Paper 44
Date: March 2, 2015

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

INTERNATIONAL SECURITIES EXCHANGE, LLC,
Petitioner,

v.

CHICAGO BOARD OPTIONS EXCHANGE, INC.,
Patent Owner.

Case IPR2014-00098
Patent 7,980,457 B2

Before JUSTIN T. ARBES, RAMA G. ELLURU, and JAMES B. ARPIN, *Administrative Patent Judges.*

ELLURU, *Administrative Patent Judge.*

FINAL WRITTEN DECISION
35 U.S.C. § 318(a) and 37 C.F.R. § 42.73

I. BACKGROUND

Petitioner, International Securities Exchange, LLC, filed a Petition (Paper 1, "Pet.") requesting *inter partes* review of claims 1–7 of U.S. Patent No. 7,980,457 B2 (Ex. 1001; "the '457 patent"). Patent Owner, Chicago Board Options Exchange, Inc., filed a Preliminary Response opposing institution of review (Paper 9; "Prelim. Resp."). On May 22, 2014, we instituted an *inter partes* review of claim 1 of the '457 patent (Paper 12; "Dec. on Inst.").

Subsequent to institution, Patent Owner filed a Patent Owner Response (Paper 26; "PO Resp."), a Motion to Amend Claims (Paper 28, "Mot."), and a Reply to Petitioner's Opposition to the Motion to Amend Claims (Paper 35, "PO Reply"). Petitioner filed a Reply to Patent Owner's Response (Paper 34; "Pet. Reply") and an Opposition to Patent Owner's Motion to Amend Claims (Paper 32; "Opp.").

We held an oral hearing on January 21, 2014, and a transcript of the hearing is included in the record (Paper 43; "Tr.").

We have jurisdiction under 35 U.S.C. § 6(c). This Final Written Decision is issued pursuant to 35 U.S.C. § 318(a) and 37 C.F.R. § 42.73.

For the reasons that follow, we determine that Petitioner has not shown by a preponderance of the evidence that claim 1 of the '457 patent is unpatentable based on the instituted ground in this *inter partes* review.

A. The '457 Patent

The '457 patent, titled "Automated Trading Exchange System Having Integrated Quote Risk Monitoring and Integrated Quote Modification Services,"

issued on July 19, 2011, based on U.S. Patent Application 12/035,996 ("the '966 application"), filed February 22, 2008.[1]

The '457 patent relates to automated trading systems for option contracts ("options"). Ex. 1001, 1:15–19, Abstract. Specifically, the claimed invention is directed to systems for managing the risk of a maker of an options market in an automated trading system. *Id*. at 1:15–19.

Options are traded publicly on exchanges. *Id*. at 1:24. Each option covers certain rights to buy or sell an underlying security at a fixed price for a specified period of time. *Id*. at 1:25–28. The potential loss to the buyer of an option is no greater than the initial premium paid for the option, regardless of the performance of the underlying security. *Id*. at 1:34–36. On the contrary, in exchange for the premium, the seller of the option ("the market-maker") assumes the risk of being assigned the obligation to buy or sell the underlying security, according to the option terms, if the contract is exercised. *Id*. at 1:37–41. Thus, writing options may entail large risks to the market-maker. *Id*. at 1:41–42.

Many option trading systems utilize an "open outcry" method. *Id*. at 1:50–51. In such systems, market-makers are required to make a two-sided market by providing an order and offer quote. *Id*. at 1:51–53. In a non-automated open outcry system, a market-maker communicates verbally with traders indicating their willingness to buy and sell various quantities of securities. *Id*. at 1:53–56.

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[1] The '996 application is a continuation of U.S. Patent Application No. 09/475,534 ("the '534 application), which issued as U.S. Patent No. 7,356,498 B2 ("the '498 patent"). U.S. Patent Application No. 13/178,289 ("the '289 application") is a continuation of the '996 application and issued as U.S. Patent No. 8,266,044 B2 ("the '044 patent"). The '457 patent is also the subject of CBM2013-00050. The '498 patent is the subject of CBM2013-00049 and IPR2014-00097. The '044 patent is the subject of CBM2013-00051. Final Written Decisions are entered in these cases concurrently with this Decision.

Because a market-maker in such systems has personal control over the types and number of options traded, the market-maker can manage risk associated with his or her options portfolio. *Id*. at 1:56–58. A market-maker manages risk by modifying quotes for options to favor trades that tend to hedge against unwanted risk. *Id*. at 1:58–62.

The ’457 patent Specification states that an automated trading environment already was known in the art. *Id*. at 1:63–65, 2:1–2. An automated computer-based trading system typically records quotes and automatically matches them with orders that enter the system. *Id*. at 1:65–2:1. One disadvantage of known automated trading systems is that the systems execute trades so rapidly that a market-maker may be unable to withdraw or modify his quotes in a timely manner. *Id*. at 2:7–12. Software tools that assess trading option portfolio risk and recommend quote modifications also were known. *Id*. at 2:13–18. An automated trading system, however, processes transactions in the order received. *Id*. at 2:23–25. Thus, even if a market-maker uses such software tools to modify quotes, those tools may be unable to act in time, given the speed at which the automated trading exchange system executes orders. *Id*. at 2:18–23. For example, an automated trading exchange may have a message queue containing additional orders that must be processed before the automated exchange receives and processes the market-maker’s quote modification request. *Id*. at 2:25–30. These known automated trading exchange systems, therefore, limit a market-maker’s ability to manage risk. *Id*. at 2:31–39. The ’457 patent Specification recognizes the need for a method that automatically modifies quotes under certain trading conditions in an automated trading exchange system. *Id*. at 2:40–42.

The invention of the ’457 patent is directed to systems for an automated trading exchange that modify quotes, where the system provides integrated quote

risk monitoring and quote modification services. *Id*. at 2:46–48. Thus, one aspect of the invention is an apparatus that implements the method using a computer, having memory, a processor, and a communication port. *Id*. at 2:48–51.
The computer receives orders and quotes, wherein a quote has associated trading parameters, such as a risk threshold. *Id*. at 2:51–54. The computer then may generate a trade by matching the received orders and quotes to previously received orders and quotes. *Id*. at 2:61–63. If a trade is not generated, the computer stores each of the received orders and quotes. *Id*. at 2:63–64. The computer determines whether a market-maker's quote has been filled as a result of the generated trade, and, if so, determines a risk level and aggregate risk level associated with the trade. *Id*. at 2:64–3:1. The computer then compares the aggregate risk level with the market-maker's risk threshold for a quote; if the threshold is exceeded, the computer automatically modifies at least one of the market-maker's remaining quotes. *Id*. at 3:1–4.

B. Illustrative Claim

Claim 1 is an independent claim and is reproduced below:

> 1. A system for processing trades of securitized instruments based on security orders and quotes received from client computers, comprising:
>
> at least one server computer comprising a memory, and a processor, said server computer configured to perform the steps of:
>
> receiving orders and quotes, wherein specified ones of said quotes belong to a quote group, and wherein said specified ones of said quotes have associated trading parameters comprising a risk threshold;
>
> generating a trade by matching said received orders and quotes to previously received orders and quotes;
>
> storing each of said orders and quotes when a trade is not generated;
>
> determining whether a quote having associated trading parameters has been filled as a result of the generated trade, and if so,

determining a risk level and an aggregate risk level associated with said trade;

comparing said aggregate risk level with said risk threshold; and,

automatically modifying at least one of the remaining specified ones of said quotes in the quote group if said threshold is exceeded.

C. Prior Art

The pending ground of unpatentability in this *inter partes* review is based on the following prior art.

Patent/Publication No.	Date of Issuance or Publication	Exhibit No.
U.S. Patent No. 6,405,180 B2 ("Tilfors")	June 11, 2002	Ex. 1002

Petitioner also relies upon the Declaration of Dr. Maureen O'Hara. Ex. 1004.

D. Pending Ground of Unpatentability

We instituted an *inter partes* review of the '457 patent based on the following ground:

Claim 1 is anticipated under 35 U.S.C. § 102(e) by Tilfors.

Dec. on Inst. 18.

II. ANALYSIS

A. Claim Construction

Consistent with the statute and the legislative history of the AIA,[2] the Board will interpret claims using the broadest reasonable construction in light of the specification of the challenged patent. *See Office Patent Trial Practice Guide*, 77 Fed. Reg. 48,756, 48,766 (Aug. 14, 2012); 37 C.F.R. § 42.100(b); *In re Cuozzo*

[2] Leahy-Smith America Invents Act, Pub. L. No. 112-29, 125 Stat. 284 (2011) ("AIA").

Speed Techs., LLC, No. 2014-1301, 2015 WL 448667, at *5–8 (Fed. Cir. Feb. 4, 2015). There is a "'heavy presumption' that a claim term carries its ordinary and customary meaning." *CCS Fitness, Inc. v. Brunswick Corp.*, 288 F.3d 1359, 1366 (Fed. Cir. 2002) (internal citation omitted).

In our Decision on Institution, we construed certain claim terms as follows:

Claim Term	Construction
"risk level . . . associated with said trade"	"a calculated, measured, or otherwise obtained value of exposure to the possibility of loss related to said trade"
"aggregate risk level associated with said trade"	"a calculated, measured, or otherwise obtained aggregate value (e.g., combination, sum, weighed sum, difference) of exposure to the possibility of loss related to such trade"
"automatically modifying at least one of the remaining specified ones of said quotes in the quote group if said threshold is exceeded"	"automatically cancelling or revising a price or quantity of at least one of the received specified quotes still available for execution"

Dec. on Inst. 8–11. Petitioner does not challenge these constructions (Tr. 6:18–7:2), nor does Patent Owner (*id*. at 39:14–15, 40:1–3). We discern no reason to deviate from our constructions in our Decision on Institution for purposes of this Final Written Decision.

B. Anticipation of Claim 1 by Tilfors

With respect to Petitioner's contention that claim 1 is anticipated by Tilfors, we have reviewed Petitioner's arguments and the evidence relied upon by Petitioner, and conclude that Petitioner has not established by a preponderance of the evidence that claim 1 is anticipated by Tilfors. Specifically, Petitioner has not established by a preponderance of the evidence that Tilfors discloses "determining

a risk level and an aggregate risk level associated with said trade," as recited by claim 1.

Petitioner refers predominantly to one passage in Tilfors as disclosing the limitations of claim 1. *See* Pet. 26, 28–29, 33, 35 (citing Ex. 1002, 4:46–62); Pet. Reply 2 (citing Ex. 1002, 4:46–62); Tr. 8:4–22, 18:19–25. The relied-upon passage provides the following:

> However, in a preferred embodiment, the step 211 can be executed in the following manner (not shown). If the total volume is only a little smaller than the volume required by the exchange, the step up parameter is used to automatically generate more volume at the current price. If, on the other hand, a larger volume needs to be generated in order to obtain the volume X, the one tick worse parameter is used to generate the requested volume at a worse price. Also, if in the step 211, the step up parameter has been used to generate more volume a number of consecutive times at the same price, the one tick worse parameter can be used, even though the step-up parameter normally should have been used. This will prevent that a customer enters a large number of small orders and that the system then generates more volume at the current price instead of offering a worse price as would have been the case if the customer had entered one large order.

Ex. 1002, 4:46–62. Petitioner explains that Tilfors's "step up functionality allows a partially filled quote to be automatically modified by increasing the volume in the quote to a predetermined level set by the market maker or the exchange." Pet. 23. Petitioner provides the following example—if the market-maker's original quote was for 50 option contracts, and the market-maker trades against an order for 20 contracts, 30 contracts remain in the quote. *Id*. The step-up function automatically modifies the quote to increase the volume back up to the predetermined level ("X"), which could be, for example, 50 contracts. *Id*.; *see* Ex. 1002, 4:37–41 ("X is a parameter predefined by the exchange").

Petitioner maintains that when Tilfors executes trades, risk level and aggregate risk level are tracked. Pet. 26. According to Petitioner, "[e]ach trade against a quote, and implementation of the step up function, carries with it an inherent risk level as volume is added." *Id*. (citing Ex. 1004 ¶ 50). Petitioner further contends that "Tilfors counts the number of step ups applied against a quote, thus determining an 'aggregate risk level.'" *Id*. at 26–27 (citing Ex. 1002, 4:46–62, 6:45–53). Petitioner argues that the recited "risk threshold" "reads directly on the programmed *number of times* the step up parameter is permitted to generate more volume at the same prices before invoking tick worse." *Id*. at 27 (citations omitted; emphasis added). With respect to the "modifying" limitation of claim 1, Petitioner asserts that "[w]hen the step up count threshold is exceeded, tick worse is invoked, which regenerates the quote at a worse price," which according to Petitioner, is "something the '457 patent makes clear is one of the ways a quote can be modified in response to exceeding a risk threshold." *Id*. (citations omitted).

In our Decision on Institution, based on the record then before us, we instituted a review based on the following determinations.

> [W]hether or not a trade triggers a step-up in volume is a calculation of the market maker's exposure to the possibility of loss related to a trade, i.e., the claimed "risk level." Ex. 1004 ¶ 51.

Dec. on Inst. 14. We further agreed with Petitioner that the number of step-ups, i.e., volume increases, applied against a quote, satisfies the recited "aggregate risk level." *Id*. We also determined that because a tick worse parameter is applied if a step-up has been triggered a pre-defined number of times, Petitioner had made a sufficient showing that Tilfors discloses "automatically modifying at least one of the remaining specified ones of said

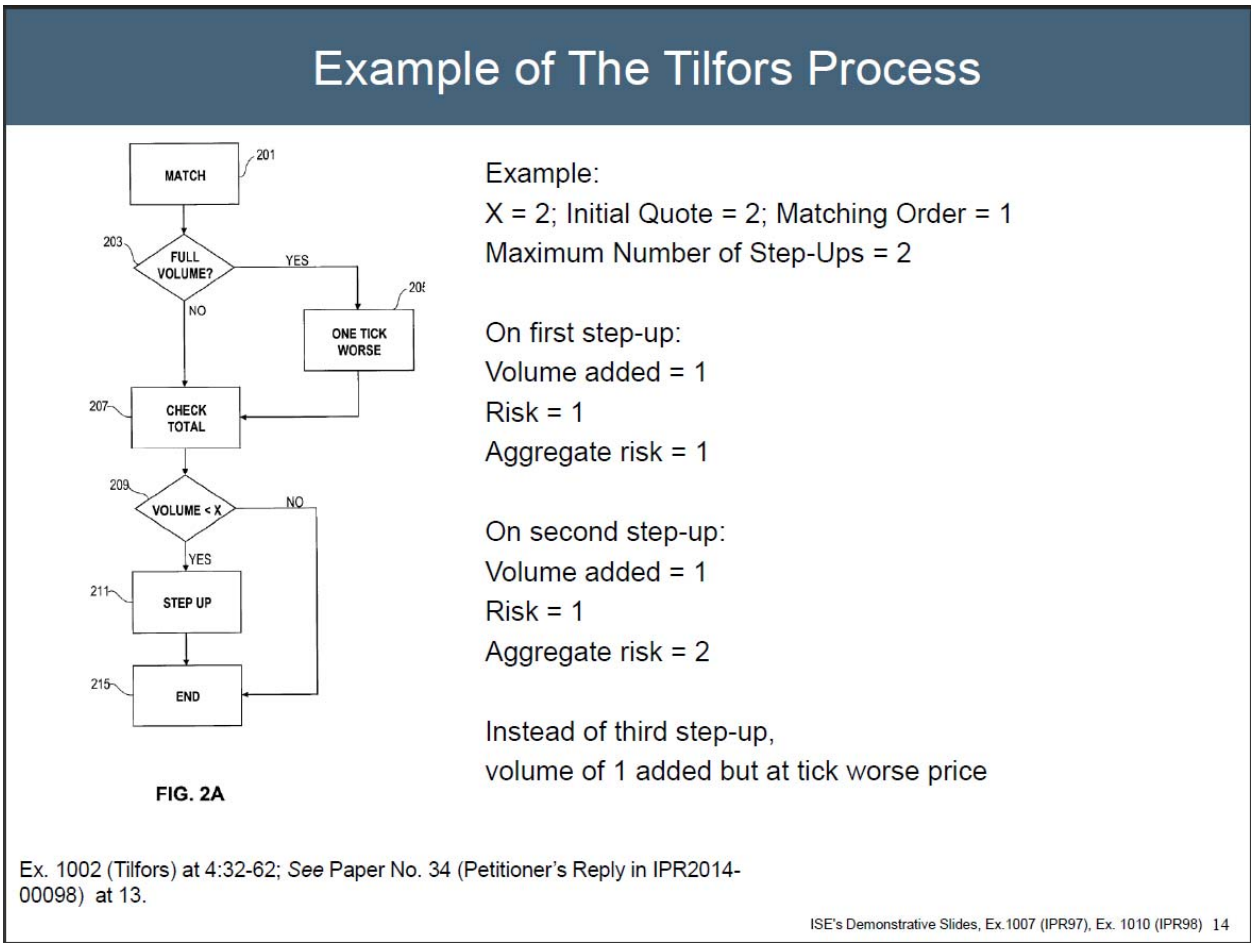
quotes in the quote group if said threshold is exceeded," as recited by claim 1. *Id*.

Patent Owner disagrees that Tilfors discloses "determining a risk level . . . associated with said trade." PO Resp. 27–32. Specifically, Patent Owner argues that "whether or not a trade triggers a step-up" does not satisfy the recited "risk level . . . associated with said trade," which we interpreted as "a calculated, measured, or otherwise obtained *value of exposure to the possibility of loss related to said trade*." *Id*. at 28 (emphasis added); *see* Dec. on Inst. 8–9. According to Patent Owner, whether or not a trade triggers a step-up is merely a decision to maintain the exchange-required minimum volume and "is clearly not a value of anything." PO Resp. 28. Patent Owner asserts that "whether or not a step-up is triggered is merely a yes-or-no question about exchange volume with only a yes-or-no answer." *Id*. Thus, argues Patent Owner, the decision to step-up is not "a calculated, measured, or otherwise obtained *value of exposure*, but rather a determination to fulfill an exchange requirement." *Id*. (emphasis in original).

In its Reply, with respect to the recited "risk level . . . associated with said trade," Petitioner argues that "[e]ach step-up represents the addition of volume to a quote, and volume is a risk level." Pet. Reply 7. Thus, according to Petitioner, because each step-up represents the addition of volume—volume which could be bought by a trade—the "risk level" is increased. Tr. 20:20–21, 21:14–17, 21:18–22, 22:3–8; *see* Pet. Reply 10–12 (Petitioner's hypothetical presented to Patent Owner's witness, Dr. Benn Steil). Petitioner states that "counting step-ups effectively counts risk levels and creates an aggregate risk level." Pet. Reply 12. Petitioner further argues

that Tilfors discloses the recited "aggregate risk level" because it keeps track of the number of times volume is added in the step-up procedure. *Id*. at 7.

In support of its argument, at the oral hearing, Petitioner provided the following example of Tilfors's embodiment.



Ex. 1010, Slide 14 (citing Pet. Reply 13); *see* Tr. 19:6–20:21.[3]

Petitioner confirms that it is relying on the aspect of the embodiment illustrated in Figure 2A, in which less than the full volume of the market-

[3] For purposes of explaining the parties' positions, and ease of reference, we address herein the parties' arguments in the context of the examples discussed at the hearing. The parties' substantive arguments, on which those examples are based, however, are reflected in the parties' papers. *See, e.g.*, Pet. 21–35; PO Resp. 27–32; Pet. Reply 7–14.

maker's quote is traded consecutively (i.e., the answer is "no" at step 203 and "yes" at step 209) and more volume is generated in the market-maker's existing quote at the same price (step 211). Tr. 18:19–19:2, 26:11–16, 63:20–25; *see* Ex. 1002, 4:37–43. Thus, at least "1" contract remains in the market-maker's quote. The other aspect of Tilfors's embodiment provides that if the full volume in the market-maker's quote is traded at Tilfors's step 203 in Figure 2A, the next step is step 205. Petitioner, however, is not relying on this aspect of the embodiment. Tr. 63:17–64:6.

In the hypothetical presented by Petitioner, "X," the minimum volume required by the electronic exchange, is "2" contracts (*id*. at 19:24–25), the predefined number of step-ups (i.e., what we determined at institution is the claimed "risk threshold") is "2" (*id*. at 19:11–15), the market-maker's initial quote is for "2" contracts, and there is a matching order for "1" contract (*id*. at 19:16–17, 20:1–2). According to Petitioner, after the first trade, because the "full volume" of the market-maker's quote was not traded according to step 203 (i.e., one contract still remains in the market-maker's quote), the process proceeds to step 207. *Id*. at 20:5–10. At step 207, the process checks whether the total volume remaining in the market-maker's quote, "1" contract, is less than the "2" contract minimum required by the exchange. *Id*. at 20:10–12. Because the remaining volume in the market-maker's quote is less than X, the minimum required by the exchange, a step-up application is triggered (step 211), whereby volume ("1" contract) is added to the market-maker's quote to satisfy X, at the market-maker's current price. Ex. 1010, Slide 14; Tr. 19:20–20:2; Ex. 1002, 4:47–50. According to Petitioner, "one step-up equals a risk level of one," so the market-maker's risk level after the first trade in the hypothetical is "1" and the claimed "aggregate risk

level" is "1." Tr. 20:13–21, 22:16–19. Petitioner further contends that the claimed "risk level" does not depend on the price of the contract traded. *Id*. at 21:18–22:8. Petitioner further argues that the "risk level" is "1" each time a step-up is applied, and that after applying the step-up functionality twice, the "aggregate risk level" is "2." Ex. 1010, Slide 14.

Petitioner acknowledges that, based on the relied-upon Tilfors embodiment, the volume added to a market-maker's quote during a step-up can be more than "1" contract. Tr. 23:16–24. For example, Petitioner explains that if X is equal to "11," a market-maker knows that every time Tilfors's step-up is applied, the volume added to his quote could be "1" contract "up to 10 contracts." *Id*. at 27:5–10. Petitioner, however, maintains that although any time a trade triggers a step-up, the volume of contracts that can be added could be a range, the "risk level" is "1" "because that represents one increase in volume" and "[h]ow many times you've increased that volume is your aggregate risk value." *Id*. at 28:11–16, 29:6–25. Thus, according to Petitioner, Tilfors discloses that the "risk level" is "1" whenever an executed trade triggers a step-up, regardless of any other information, including the volume of the executed trade and the volume that is added when the step-up is applied to the market-maker's quote. *Id*. at 30:6–24.

> JUDGE ELLURU: So, you're saying the risk value is the same regardless of the number of contracts you're increasing?
>
> Mr. MURRAY: That's right. That's exactly right.

Id. at 31:1–3; 32:19–25, 34:12–16. Although Tilfors's step-up functionality may indicate an increase in risk because it is an indication that volume needs to be added to a market maker's quote, Petitioner has not persuaded us that

Tilfors discloses the claimed "risk level"—which the parties do not contest means "a calculated, measured, or otherwise obtained value of exposure to the possibility of loss related to said trade." *See supra* Sec. II.A.

Foremost, Petitioner has not shown sufficiently that Tilfors expressly discloses "determining" a "risk level . . . associated with said trade." *See* Tr. 22:20–23:2. Based on our review of the record, Petitioner has not shown sufficiently that Tilfors describes determining a specific "risk level" value, "1," as asserted by Petitioner. Although Tilfors keeps track of the number of times a market-maker has stepped up (*id*.), we are not persuaded that that disclosure describes determining a "risk level" of "1" for each "such trade." Furthermore, we are not persuaded that under our construction, a "risk level" for a particular trade can be calculated without taking into account critical information, such as volume traded, volume remaining in the market-maker's quote, price of the trade, etc. *See id*. at 40:18–21. As Patent Owner contends, the recited "risk level" is for each "such trade," i.e., "[a] trade that has already taken place." *Id*. at 37:6–9; *see id*. at 40:4–5. Petitioner argues that any trade that triggers a step-up in the relied upon embodiment in Tilfors has a "risk level" of "1." A "risk level" of "1," however, does not take into account the volume that was traded in the executed trade, nor does "1" reflect the amount of volume that may be added by Tilfors's step-up function. Even accepting Petitioner's assertion that Tilfors's step-up is an "indication" of risk because it tells a market-maker that volume has been added to the quote (*id*. at 31:11–14, 65:18–23), and the market-maker is aware of the range of volume that has been added to his quote, (i.e., 1 to X, the minimum number of contracts that must be quoted by the market-

maker), *that range*, calculated mentally by the market-maker, would not be represented by a "risk level" of "1." *See id*. at 31:3–14, 37:19–21, 65:13–24.

The absence of a correlation between whether a step-up has been triggered in the relied upon embodiment in Tilfors and our uncontested interpretation of "risk level" of an executed trade is illustrated by specific examples. Applying the embodiment in Tilfors relied upon by Petitioner, if "X" is "100," and a market-maker has "101" contracts outstanding in the exchange's order book, and "2" contracts are traded, the market-maker's available quote drops to "99" contracts (step 209). *Id*. at 37:22–24. Pursuant to the embodiment described in Tilfors, a step-up function (step 211) would be applied to increase the market-maker's available quote by "1" contract to reach "X." *Id.* at 37:24–35:1; Ex. 1002, Fig. 2A (steps 209 and 211). According to Petitioner's argument, "2" contracts have been traded, and the "risk level" is "1" because one step-up has been triggered. Tr. 38:1–2.

In another example, if "X" is "100," and a market-maker has "200" contracts outstanding in the exchange's order book, and "101" contracts are traded, the market-maker's available quote drops to "99" contracts (step 209). As in the example above, a step-up function (step 211) would be applied to increase the market-maker's available quote by "1" contract to reach "X." Pursuant to Petitioner's argument, "101" contracts have been traded, and the "risk level" is "1" (the same "risk level" as in the preceding example in which "2" contracts were traded) because one step-up has been triggered. This example demonstrates that a "risk level" of "1" does not take into account the volume of the executed trade (i.e., the recited "said trade" in claim 1). In yet another example, if "X" remains "100," and a market-maker

has "101" contracts outstanding in the exchange's order book, and "100" contracts are traded, the market-maker's available quote drops to "1" contract (step 209). Pursuant to the embodiment described in Tilfors, a step-up function (step 211) would be applied to increase the market-maker's available quote by "99" contracts to reach "X." According to Petitioner's argument, "99" contracts have been added to the market-maker's quote and the "risk level" is "1" (the same "risk level" as in the first example in which "1" contract was added to the market-maker's quote) because one step-up has been triggered. This example demonstrates that a "risk level" of "1" does not take into account the volume added to a market-maker's quote when a step-up is triggered by an executed trade (i.e., the recited "said trade" in claim 1). In sum, these examples demonstrate to us the indefensible nature of Petitioner's argument.

We also do not find the testimony provided by Petitioner's witness, Dr. Maureen O'Hara, in support of Petitioner's argument to be persuasive. Dr. O'Hara states, for example, "Tilfors/Katz *examines* the risk level by looking at whether or not a trade triggers a step up." Ex. 1004 ¶ 48 (emphasis added); *see* Ex. 2012 ¶ 52 (Patent Owner's witness testifies that "no risk level (i.e., value) is ever determined in Tilfors"). Dr. O'Hara also testified as follows:

> Q: So the risk level is the fact that we're stepping up?
>
> A: That is kind of strange; right?

Ex. 2013, 187:5–7. Dr. O'Hara did not provide a satisfactory explanation as to how Tilfors discloses the recited step of "determining a risk level . . . associated with said trade."

> Q: I'm just talking about the decision whether or not to step up.

A: So the decision to step up is *related to the market maker's risk*.

Id. at 93:16–19 (emphasis added). In addition, Dr. O'Hara testified that not stepping-up, i.e., not increasing the volume in a market-maker's quote, also represents risk.

Q: So the measure of risk was what?

A: It was the fact that I had to step up, it was the trade.

. . .

Q: And the [market-maker's] risk is not being in the market?

A: The risk is not having a quote that can be hit by people who want to trade.

Id. at 203:22–24, 93:21–23. As Patent Owner notes (PO Resp. 30 n.4), however, when a trade triggers a step-up in volume, which Petitioner contends has a risk level of "1," Tilfors does not keep track of the risk to which Dr. O'Hara refers, i.e., not increasing the volume in a market-maker's quote so that it "can be hit by people who want to trade." Ex. 2013 93:16–23. Thus, we are not persuaded that Dr. O'Hara's testimony supports Petitioner's position that whether an executed trade triggers the application of a step-up in volume in a market-maker's quote discloses the recited "determining a risk level . . . associated with said trade."

In sum, we determine that Petitioner has not demonstrated by a preponderance of the evidence that Tilfors discloses the recited step of "determining a risk level . . . associated with said trade."

Using the same reasoning, Patent Owner also argues that Tilfors fails to disclose the recited step of "determining . . . an aggregate risk level associated with said trade." PO Resp. 31–32. We construed "aggregate risk level associated with said trade" as "a calculated, measured, or otherwise obtained aggregate value (e.g., combination, sum, weighed sum, difference)

of exposure to the possibility of loss related to such trade." *See supra* Sec. II.A. Specifically, Patent Owner contends that "[b]ecause Tilfors does not disclose determining a calculated, measured, or otherwise obtained *value of exposure* to the possibility of loss related to said trade, Tilfors . . . does not disclose determining a calculated, measured, or otherwise obtained *aggregate value* of exposure to the possibility of loss related to such trade." PO Resp. 31 (citing Ex. 2012 ¶¶ 55–60) (emphasis in original). We agree that Petitioner has not shown sufficiently that Tilfors discloses the step of "determining . . . an aggregate risk level associated with said trade."

We further agree with Patent Owner (*id*. at 31–32) that Dr. O'Hara, Petitioner's witness, does not provide persuasive testimony that Tilfors discloses the recited step of "determining . . . an aggregate risk level associated with said trade." For example, Dr. O'Hara testified as follows.

> Q: Where in Tilfors does it expressly describe the aggregate risk level?
>
> A: I'm not sure that it does. I could go through and see if it uses the word "aggregate," but I think Tilfors, Tilfors is just giving you a broad measure of risk, it just -- this is your -- a broad exposure to what's happening to you in your trading, it's -- like I said, it's a broad measure.

Ex. 2013, 162:11–19. Dr. O'Hara also testified as follows.

> Q: Has your opinion been based on your understanding that the risk level and the aggregate risk level can be the same?
>
> A: They can be. I don't know that they have to be, but they can be the same.

Id. at 179:13–17. Thus, we likewise determine that Petitioner has not demonstrated by a preponderance of the evidence that Tilfors discloses the

recited step of "determining . . . an aggregate risk level associated with said trade."

III. MOTION TO AMEND CLAIMS

Patent Owner moves to amend claim 1, "contingent upon claim 1 being held [unpatentable]." Mot. 1. Because we have not determined that claim 1 is unpatentable, we need not address Patent Owner's Motion to Amend Claims.

IV. CONCLUSION

Based on the foregoing, we determine that Petitioner has not established by a preponderance of the evidence that independent claim 1 is unpatentable as anticipated by Tilfors pursuant to 35 U.S.C. § 102(e).

We further do not address Patent Owner's Motion to Amend Claims.

This Decision constitutes a Final Written Decision under 35 U.S.C. § 318(a).

V. ORDER

In consideration of the foregoing, it is

ORDERED that claim 1 of the '457 patent has not been shown to be unpatentable based on the instituted ground in this *inter partes* review;

FURTHER ORDERED that Patent Owner's Motion to Amend Claims is dismissed as moot; and

FURTHER ORDERED that either party to this proceeding seeking judicial review of the Decision must comply with the notice and service requirements of 37 C.F.R. § 90.2.

US007356498B2

(12) **United States Patent**
Kaminsky et al.

(10) **Patent No.: US 7,356,498 B2**
(45) **Date of Patent: Apr. 8, 2008**

(54) **AUTOMATED TRADING EXCHANGE SYSTEM HAVING INTEGRATED QUOTE RISK MONITORING AND INTEGRATED QUOTE MODIFICATION SERVICES**

(75) Inventors: **Ross G. Kaminsky**, Chicago, IL (US); **Richard A. Angell**, Evanston, IL (US); **Gordon D. Evora**, Chicago, IL (US)

(73) Assignee: **Chicago Board Options Exchange, Incorporated**, Chicago, IL (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **09/475,534**

(22) Filed: **Dec. 30, 1999**

(65) **Prior Publication Data**

US 2002/0082967 A1 Jun. 27, 2002

(51) **Int. Cl.**
G06Q 40/00 (2006.01)

(52) **U.S. Cl.** **705/37**; 705/38

(58) **Field of Classification Search** 705/35, 705/37, 38, 39, 42, 44, 40, 41
See application file for complete search history.

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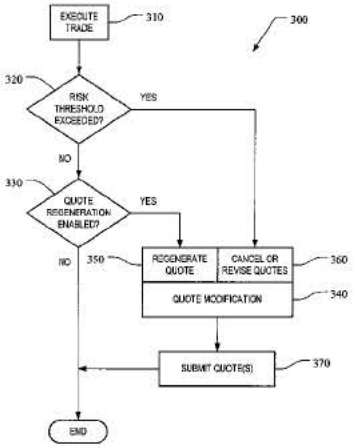
Primary Examiner—Andrew Joseph Rudy
(74) *Attorney, Agent, or Firm*—Brinks Hofer Gilson & Lione

(57) **ABSTRACT**

An automated trading exchange having integrated quote risk monitoring and quote modification services. An apparatus is implemented using at least one computer, having memory, and a processor. The computer is configured to receive orders and quotes, wherein specified ones of the quotes are contained in a quote group, and have associated trading parameters such as a risk threshold. Not all received quotes are required to have trading parameters as described herein. Preferably, the quote group contains all the quotes, or a subset of quotes, belonging to an individual market-maker for a given class of options contracts, or possibly the quotes of two or more market-makers that have identified themselves as belonging to a group for the purposes of risk monitoring and quote modification. The computer typically generates a trade by matching the received orders and quotes to previously received orders and quotes, and otherwise stores each of the received orders and quotes if a trade is not generated. The computer then determines whether a quote within the quote group has been filled as a result of the generated trade, and if so, determines a risk level and an aggregate risk level associated with said trade. The computer then compares the aggregate risk level with the market-maker's risk threshold, and if the threshold is exceeded, automatically modifies at least one of the remaining quotes in the quote group. The computer may also automatically regenerate quotes that have been filled.

28 Claims, 7 Drawing Sheets



EXHIBIT

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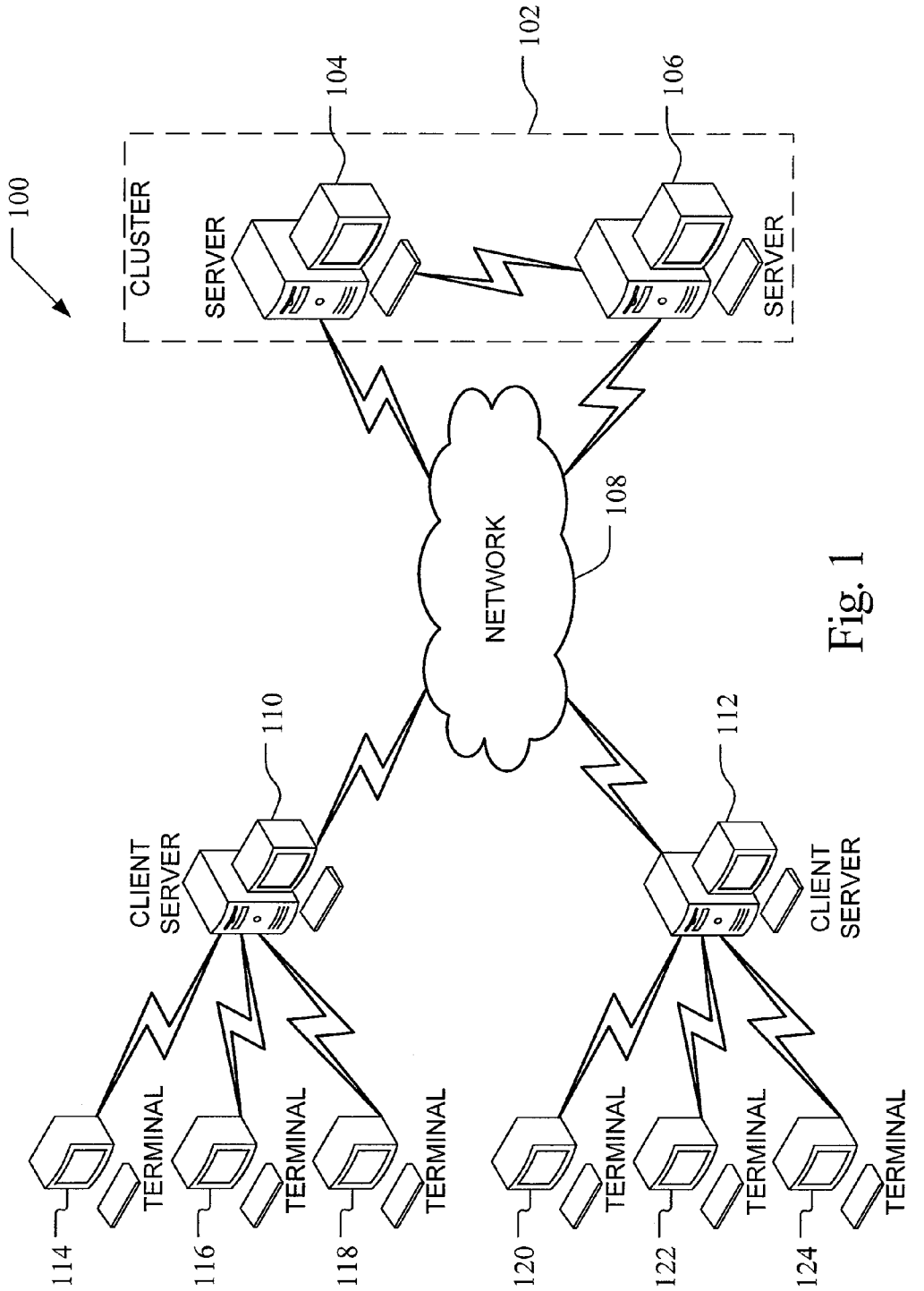
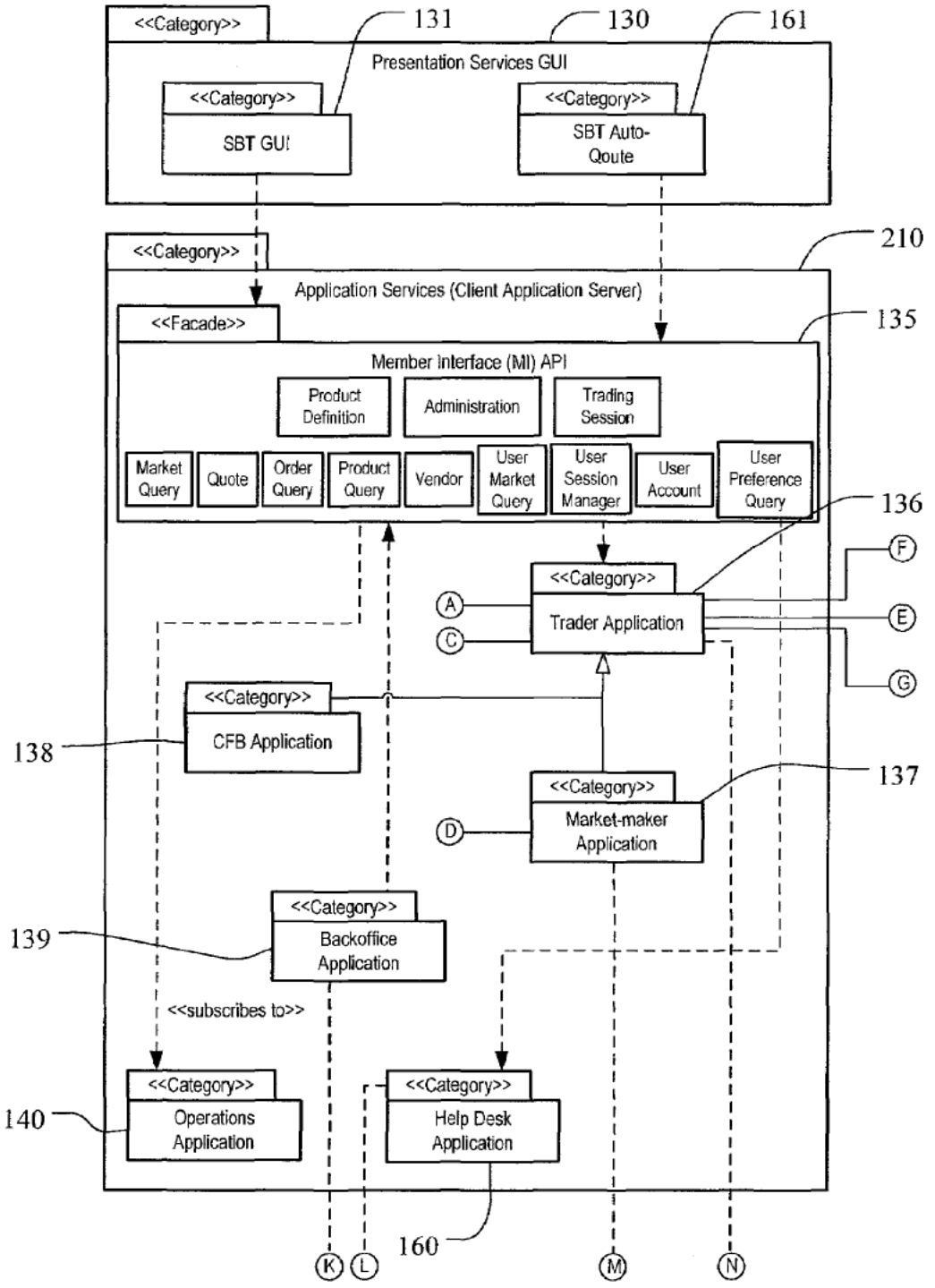


Fig. 1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SBT GUI
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SBT Auto-Qoute
<<Category>>
210
Application Services (Client Application Server)
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Member Interface (MI) API
Product Definition
Administration
Trading Session
Market Query
Quote
Order Query
Product Query
Vendor
User Market Query
User Session Manager
User Account
User Preference Query
136
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Fig. 2A

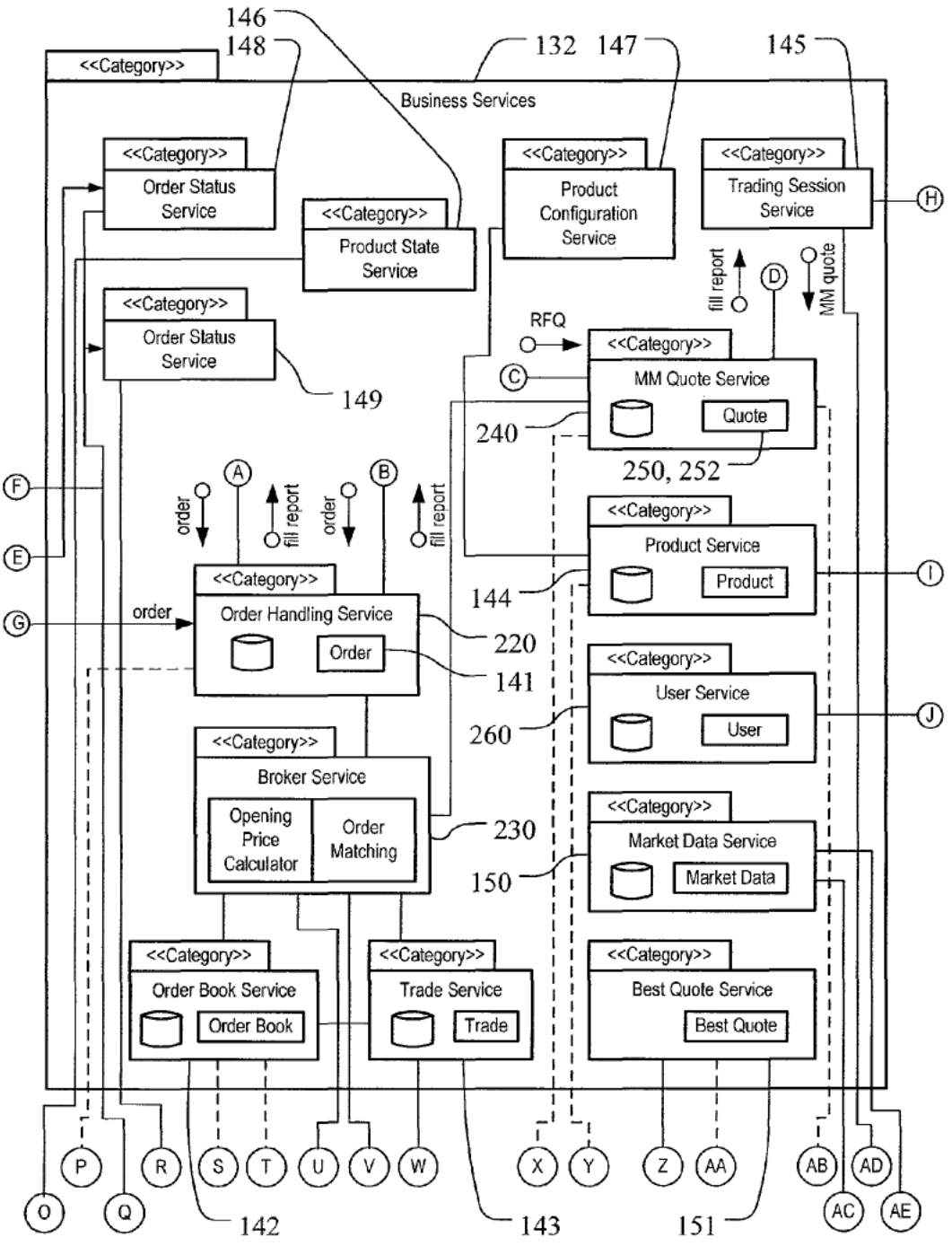
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Fig. 2B

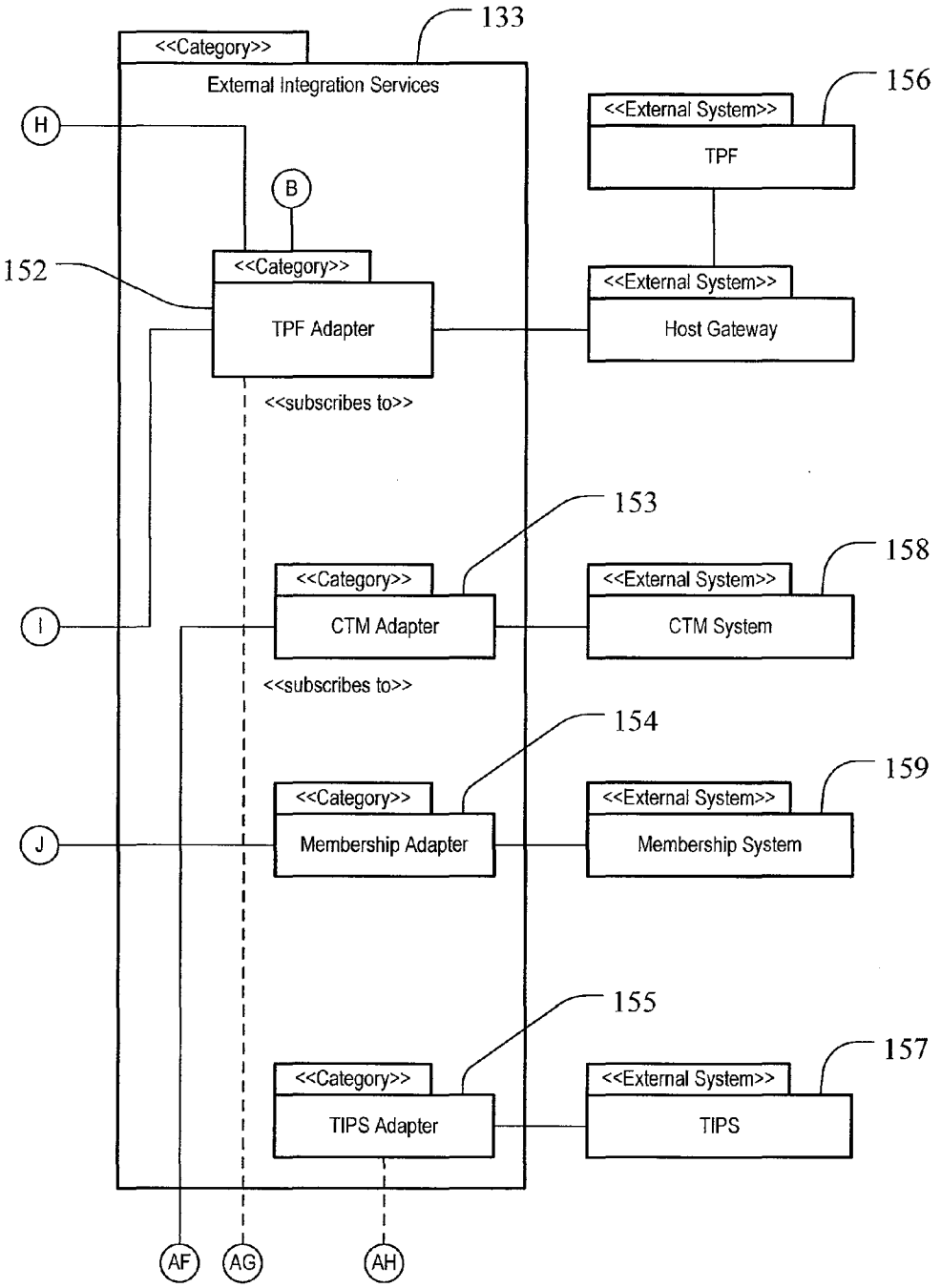
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Fig. 2C

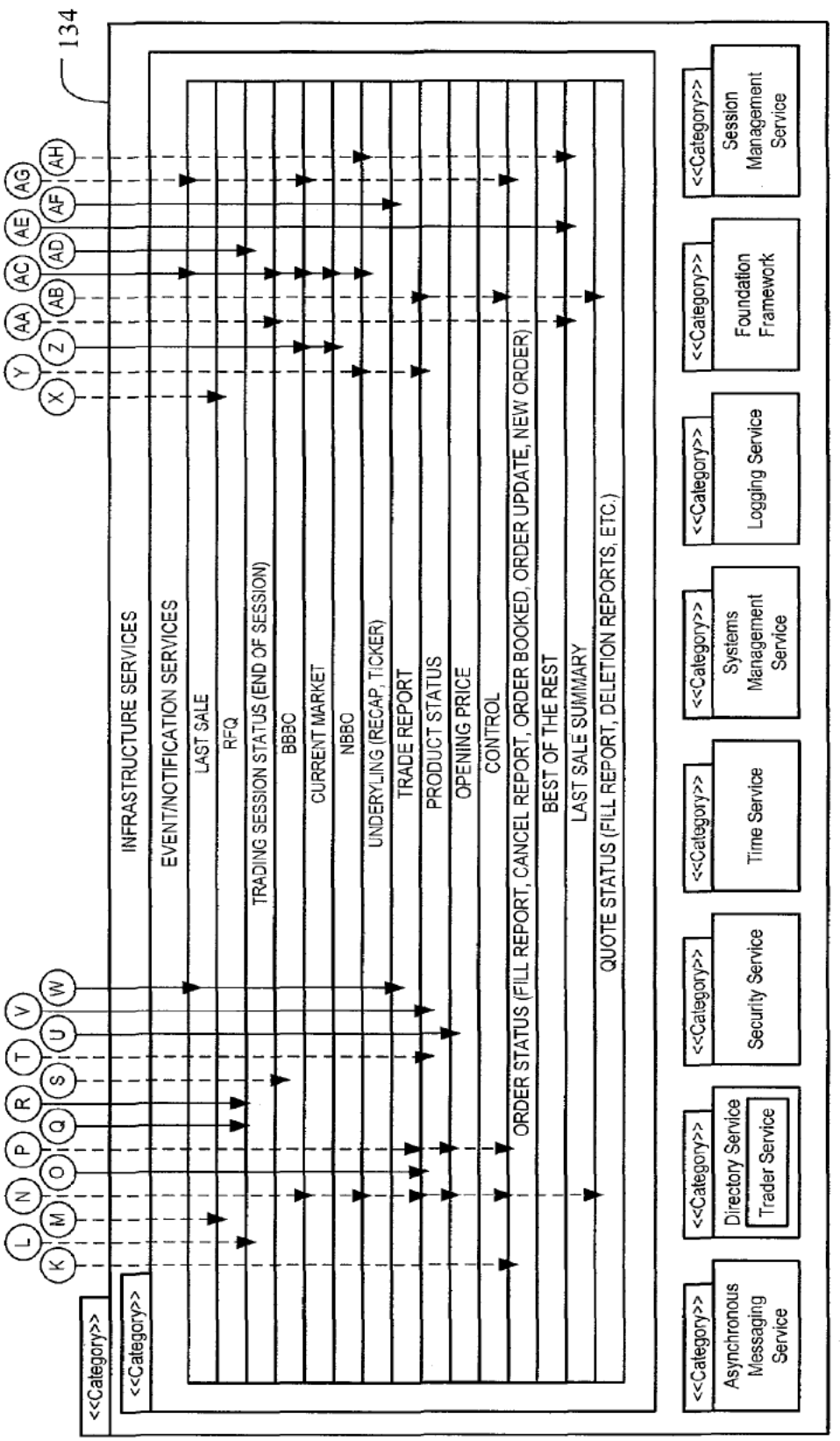

Fig. 2D

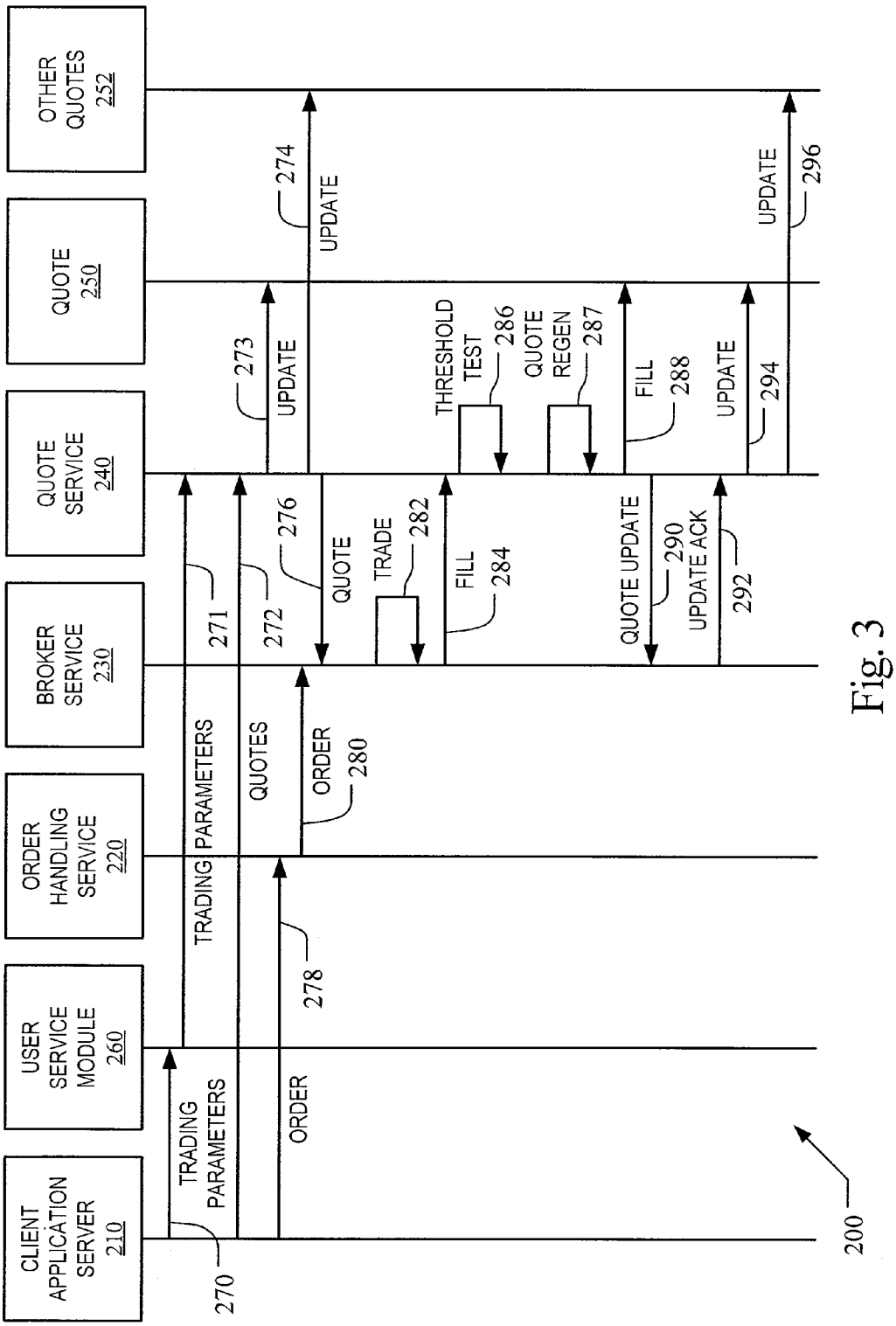

Fig. 3

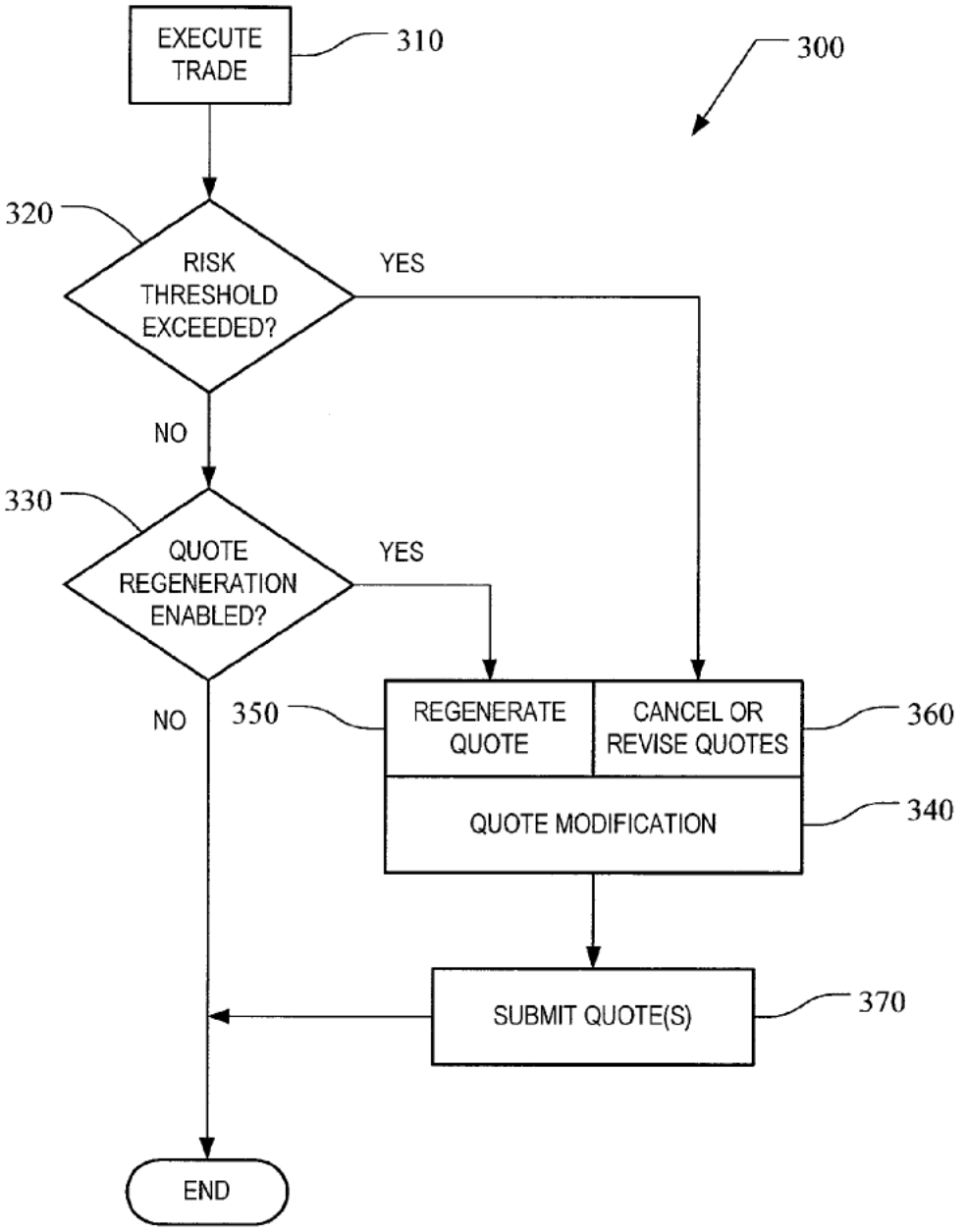
EXECUTE TRADE
310
300
320
RISK THRESHOLD EXCEEDED?
YES
NO
330
QUOTE REGENERATION ENABLED?
YES
NO
350
REGENERATE QUOTE
CANCEL OR REVISE QUOTES
360
QUOTE MODIFICATION
340
SUBMIT QUOTE(S)
370
END

Fig. 4

AUTOMATED TRADING EXCHANGE SYSTEM HAVING INTEGRATED QUOTE RISK MONITORING AND INTEGRATED QUOTE MODIFICATION SERVICES

A. FIELD OF THE INVENTION

The present invention relates to financial trading systems. More specifically, it is directed to a method and device for market-maker risk management through automatic quote risk monitoring and quote modification in an automated trading system.

B. DESCRIPTION OF THE RELATED ART

1. Option Trading

Option contracts are traded publicly on many exchanges throughout the world. These securities, referred to generally as "options," convey certain rights to buy or sell an underlying stock, commodity, or other security at a fixed price for a specific period of time—until expiration for an American-style option or at expiration for a European-style option. All option contracts that trade on U.S. securities exchanges are issued, guaranteed and cleared by the Options Clearing Corporation (OCC). OCC is a registered clearing corporation with the SEC.

The potential loss to the buyer of an option can be no greater than the initial premium paid for the contract, regardless of the performance of the underlying stock. This allows an investor to control the amount of risk assumed. On the contrary, the seller of the option, in return for the premium received from the buyer, assumes the risk of being assigned the obligation to buy or sell the underlying security if the contract is exercised. Therefore, writing options can lead to large potential exposure.

Further background information may be obtained from the book "OPTIONS, Special Concepts and Trading Strategies," The Options Institute, The Educational Division of the Chicago Board Options Exchange, Second Edition, McGraw Hill (1995), the contents of which are incorporated herein by reference.

2. Open Outcry Trading and Automated Exchanges

Many trading systems utilize what is known as an open outcry method of trading. In the open outcry system, market-makers are required to make a two-sided market by providing a bid and offer quote in all option series. The market-makers typically communicate verbally or visually with contra traders indicating their willingness to buy and sell various quantities of securities. Because the market-makers have personal control over the types and number of contracts traded, they can adjust their trading strategies as their positions change. In this way, the market-makers can manage their exposure, or risk, associated with their holdings by adjusting their quotes to favor trades that would tend to hedge away unwanted exposure.

In an automated trading environment, a certain amount of control is lost when a market-maker has issued quotes in a large number of option series. The quotes are typically recorded in the automated and computer-based trading system, and matched up automatically with orders that enter the system electronically. With the proliferation of computer trading systems and increased communication speeds, the rate at which trades may be executed by an automated system far surpass the rate of trades that occur in an open outcry system. The speeds are such that the rapidity of trades may exceed the market-maker's ability to adapt his or her position. Specifically, one disadvantage of automated trading systems is that a number of automatic trades may occur within a very short time that result in an unacceptable risk being assumed by a market-maker. That is, the trades may occur so rapidly that the market-maker is unable to withdraw or modify his quotes in a timely manner.

There exist software tools that can analyze stock and option portfolios in close to real time. Market data is provided to the software analysis tools and used to evaluate the risk associated with stock and option portfolios. In addition, the tools may provide recommendations for trades and quotes and automated submission of those trades and quotes. However, even if a market-maker utilizes such a computer-implemented automated position analysis tool to revise or cancel quotes, the software tools may be unable to act in time given the speed at which an automated trading exchange system is capable of executing incoming orders. In particular, one aspect of existing exchange systems is that transactions are received and processed in the order received. Thus, even if a market-maker responds immediately using an automated software tool, the exchange may have a message queue containing additional orders that will be processed before the exchange system receives and processes the market-maker's quote cancellation request.

The result is that a market-maker who is willing to take on a predetermined level of risk must limit the number of quotes or the depth (quantity) of each quote to ensure that rapid trades do not result in an unacceptable aggregate risk, rather than issuing quotes having greater depth and breadth (where the filling of a single quote might reach the market-maker's risk limit). Thus, a market-maker's limited control over risk management may have the undesirable effect of hindering the liquidity of the market.

It would therefore be desirable to have a trading exchange system and method for automatically canceling, regenerating, or modifying quotes under certain trading conditions.

SUMMARY OF THE INVENTION

A method and apparatus for an automated trading exchange having integrated quote risk monitoring and quote modification services is provided. In accordance with a first aspect of the invention, an apparatus is implemented using at least one computer, having memory, a processor, and a communication port. The computer is configured to receive orders and quotes, wherein specified ones of the quotes are contained in a quote group, and have associated trading parameters such as a risk threshold. Note that not all received quotes are required to have trading parameters as described herein. Preferably, the quote group contains all the quotes belonging to an individual market-maker for a given class of options contracts, or possibly the quotes of two or more market-makers that have identified themselves as belonging to a group for the purposes of risk monitoring and quote modification. The computer typically generates a trade by matching the received orders and quotes to previously received orders and quotes, and otherwise stores each of the received orders and quotes if a trade is not generated. The computer then determines whether a quote within the quote group has been filled as a result of the generated trade, and if so, determines a risk level and an aggregate risk level associated with said trade. The computer then compares the aggregate risk level with the market-maker's risk threshold, and if the threshold is exceeded, automatically modifies at least one of the remaining quotes in the quote group. The computer may also automatically regenerate quotes, that is, automatically issue new quotes when trades have occurred against previous quotes.

BRIEF DESCRIPTION OF THE DRAWINGS

The objects, features and advantages of the present invention will be more readily appreciated upon reference to the following disclosure when considered in conjunction with the accompanying drawings, in which:

FIG. **1** depicts a preferred embodiment of the quote modification trading system;

FIGS. **2**A, **2**B, **2**C, and **2**D show the interconnection of various software modules associated with the quote risk monitoring and modification trading system;

FIG. **3** shows a sequence diagram of a preferred embodiment of the quote modification system; and

FIG. **4** shows a flowchart depicting the method of modifying quotes.

DETAILED DESCRIPTION OF THE PRESENTLY PREFERRED EMBODIMENT(S)

With reference to FIG. **1**, a preferred embodiment of the system **100** utilized for trading and quote modification is described. The system **100** (also referred to herein as a screen-based trading system, or SBT system) includes a plurality of computers, which may be one or more workstations, servers, mainframes, or other computer hardware platforms that provide sufficient resources to meet the desired trading volume and desired transaction-processing rate. In the preferred embodiment shown in FIG. **1**, the system includes a number of computer clusters such as cluster **102** (although only one is depicted in FIG. **1**), where each cluster **102** handles trading for a number of securities, such as one or more classes of options. In the preferred embodiment, each cluster **102** is made up of two servers **104**, **106**. The servers **104**, **106** are preferably multiprocessor SUN **4500** servers available from SUN Microsystems of Palo Alto, Calif. SUN Enterprise™ servers or Starfire™ servers are a preferable alternative.

The servers **104** and **106** in cluster **102** communicate with a plurality of client servers **110**, **112** that are typically located at remote locations, such as at a brokerage house, but may also be located in the same facility as the clusters **102**. Network **108** facilitates communication between the clusters **102** and the client servers **110**, **112**. The network **108** is preferably a private LAN/WAN configuration, but a public network may be utilized, provided sufficient redundancies and message security are provided. Two such client servers **110**, **112** are shown in FIG. **1**. Each client server **110**, **112** may be provided with a predetermined message throughput rate into network **108**, where the throughput rate may be a maximum rate determined by various parameters, including the volume of orders sent by the client server **110**, **112**, the volume of quotes sent by the client server **110**, **112**, the number of option series for which quotes are provided, communication/connection fees paid by the brokerage house or other entity utilizing the client server **110**, **112**, the overall capacity of the trading system **100**, etc. The client servers **110**, **112** preferably communicate with other elements of the automated exchange system using a client application server module **210**, as further described below, running on client servers **110**, **112**.

Each client server **110**, **112** is capable of serving a number of clients, shown as terminals **114**, **116**, **118**, **120**, **122**, and **124** in FIG. **1**. The client terminals **114-124** may be "dumb" terminals; stand alone computing devices (PCs or workstations), or even portable wireless terminals. The client servers **110**, **112** may communicate with the client terminals **114-124** using a proprietary protocol or one of many standard

public domain protocols. The client servers **110**, **112** may include a web server or connect to a separate web server for processing tcp/ip, http, html, java, and the like, and provide access to client terminals **114-124** over the Internet in addition to (or as an alternative to) private LAN/WAN or Virtual Private Network access. For embodiments that include a webserver, the web server preferably utilizes common gateway interface scripts (cgi) to interface with the client application server **210**. In addition to cgi scripts, or as an alternative to cgi, other web server interfaces and server extensions may be utilized to provide communication between the web server and the application server **210**. The client servers **110**, **112** communicate with the users of terminals **114-124** by way of secure Internet communication protocols or by private LAN/WAN or VPN communication links. Thus the client terminals **114-124** may run dedicated proprietary software to communicate with the client server **110**, **112**, or may interface with client servers **110**, **112** via a standard web browser. The web browser may operate using built-in java scripts, or may also include specialized browser modules that are provided to the client terminals.

The automated exchange system **100** is comprised of the following five logical software modules: Presentation Services Graphical User Interface (GUI) **130** (FIG. **2**A); Application Services **210** (Client Application Server, Gateway) (FIG. **2**A); Business Services **132** (FIG. **2**B); External Integration Services **133** (FIG. **2**C); and, Infrastructure Services **134** (FIG. **2**D).

With reference to FIG. **2**A, the Presentation Services GUI module **130** is constituted by applications that interact with the exchange system **100** via the Member Interface (MI) API **135**. There are two types of client applications, those that provide a GUI to allow user interaction with the system directly and applications that automate trading functions.

An SBT (screen-based trading) GUI module **131** is responsible for displaying the contents of a particular model to the screen and updating the display if the model's contents change. This module **131** contains several GUI applications, one for each of the major classes of human actors that use the system **100**: traders, market-makers, clearing firm brokers, and system operators. The Trader GUI is used by regular traders. It consists of several GUI's for displaying and entering orders, and market data. The Market-Maker GUI is an extension of the Trader GUI and is used by market-makers. It consists of several GUI's for displaying and entering orders, quotes, and market data. The Clearing Firm Broker GUI is an extension of the Trader GUI and used by clearing firm brokers. It consists of several GUI's for forcing the logout of a market-maker and for setting a maximum order quantity for the quotes and orders of the clearing firm's market-makers. The system operation GUI is used by system operators and help desk operators. The autoquote system **161** runs on the market-maker's work station and is used by the market-maker to generate quotes for various option series.

The Application Services module **210** contains subordinate modules that forward requests initiated by human or automated actors, to be executed by the appropriate Business Services module(s) **132**. These applications submit requests to Business Services components **132**, notify clients of business events, and maintain user-specific views of information in the Business Services **132**. This module also encompasses a Member Interface (MI) API **135** that provides a single entry point to the system exposing the applications in the Application Services Module **210** (i.e., Trader, Market-Maker). In addition, the Application Services Module **210** maintains instantaneously updated views

that reflect the prevailing state of each actor's information in the Business Services module **132**.

The Trader Application module **136** has the following specific responsibilities: submit, cancel, update, and cancel/replace orders; submit requests for quotes; present the current status of the trader's orders; present fill and cancel reports; present Market Best Bids and Offers for selected products; set the trader's defaults and preferences; present Book Depths for selected products; and, present underlying quotes/last sales and news alerts.

The Market-Maker module **137** inherits the Trader App module's **136** responsibilities and adds the following: submit and modify market-maker quotes; present requests for quotes; set the market-maker's defaults and parameters; set autoquote parameters; submit autoquotes.

The Clearing Firm Broker module **138** inherits the Trader App module's **136** responsibilities and adds the following: assume control of a trader's privileges. A Clearing Firm Broker can force the logout of a market-maker; set a maximum order quantity for quotes and orders of the clearing firm's market-makers.

The BackOffice application **139** is responsible for reporting order status information. This can include fill reports, cancel reports and new order notifications. The Operations application **140** has the following responsibilities: start and shutdown the SBT system; start and stop trading of a product; change the status of a product's market (pre-open, open, close, halt, etc.); present logged system events; maintain SBT-specific trader information; maintain SBT-specific product information; maintain trading parameters (quote width, minimum market-maker order default size, required percent of responses to a request for quote (RFQ), maximum response time to an RFQ, etc).

The functionality of the Trader **136**, Market-Maker **137**, Clearing Firm Broker **138**, and Back Office **139** modules is exposed by a facade, the Member Interface (MI) Application Programming Interface (API) **135**. The Member Interface **135** exposes different subsets of functionality depending on the user that logged on to the system. The intention behind sharing a common API among the different trader classes is to allow workstations to service all of them. Separate API's may alternatively be used for the different user classes.

The Member Interface API **135** supports both SBT client applications and external applications owned by members. Members use the Member Interface API to link their existing computer systems to the exchange system **100**, to submit orders electronically and to automate trading. Likewise, market-makers use the API to submit autoquotes employing their proprietary systems, instead of the default autoquote application **161** provided by SBT.

The following system functions are preferably accessible through the API: session logon and logoff; market state inquiry and change notification; connection status inquiry and change notification; order entry, cancellation, and replacement; quote entry, cancellation, and replacement; RFQ notification; order status inquiry and fill notification; subscription to product markets; best market quotes notification; book "depth" inquire and change notification.

Referring now to FIG. **2**B, the Business Services module **132** contains the core functionality of the automated exchange system **100**. It includes components that correspond to the key business object model entities of the automated trading system such as members, orders, books, products, quotes, et cetera. In addition, it includes components to administer and operate the system **100**.

The Order Handling Service module **220** maintains the current state of all orders persistently. Specific operations may be exposed directly by Order objects **141**, bypassing the Order Handling Service **220**. Logically, Orders are components of this module. Specifically, the Order Handing Service **220** and Order components are responsible for: receiving and storing incoming orders (from SBT clients or TPF **156** (FIG. **2**C)); forwarding incoming orders to the Broker module for execution; receiving order state change notifications from the Broker and Order Book modules and updating stored orders with this information (the functionality is provided by exposing Orders, allowing the Broker and Order Book components to directly update the orders); sending fill reports to originating traders upon receiving fill notifications from the Broker and Order Book modules; receiving order cancellation requests and forwarding them to the Broker and Order Book modules (upon confirmation of a cancellation, notifying the originating trader of the result of the request and updating the stored state of the order); and receiving order cancellation/replacement requests and forwarding them to the Broker and Order Book modules (upon confirmation of the cancellation/replacement, notifying the originating trader of the result of the request and updating the stored state of the order).

The Broker Service module **230** is responsible for executing the following types of orders: limit, market, all or none, fill or kill, immediate or cancel, stop, stop limit, and spread. Upon trade execution, the Broker Service **230** is responsible for notifying the Trade Service module **143** of all the orders matched (all parties to the trade) in the trade. It is also responsible for notifying the Order Handling Service (i.e. Orders) **220** and Market-Maker Quote Service (i.e. Quotes) **240** of the fills.

The responsibilities of the Order Book Service module **142** are: cooperate with the Broker Service **230** in calculating the opening price during a product's pre-opening period; acknowledge that an order was accepted by publishing an event consumed by the Trader application **136** which originated the order; cancel and cancel/replace resting orders; upon changes to the top of the book, publish the new Book Best Bid Offer (BBBO) and last sale.

The responsibilities of the Trade Service module **143** are: receive trade notifications from the Broker Service **230**; format trade reports; store trade reports; and forward trade reports to trade match (via TPF **156**).

The Market-Maker (MM) Quote Service module **240** is responsible for: receiving requests for quotes (RFQs) from traders; submitting RFQs to market-makers assigned to the product for which the quote was requested (by publishing in the RFQ event channel); receiving and logging market-maker responses to RFQs (market-maker quotes); upon receiving a market-maker quote, saving it persistently and submitting them to the Broker Service module **230** for execution; sending fill reports to originating market-makers upon receiving fill notifications from the Broker and Order Book modules; canceling or updating a Market-Maker quote upon receiving a request from the originating market-maker by submitting the request to the Broker/Order Book; canceling or updating or regenerating Market-Maker quotes upon receiving a fill report; upon inquiry, providing the history of the quotes submitted by a market-maker.

The Product Service module **144** maintains all product-related information. In order to perform its responsibilities, the Product Service module **144** downloads, and preferably caches, product information from TPF **156** and TIPS **157**. The User Service module **260** maintains all user-related information, both specific to SBT and contained in the Membership System. It provides a unified interface to SBT

components accessing user information, hiding the actual location of the maintained data, thus simplifying client logic.

The User Service module **260** maintains the information of traders, market-makers, clearing firm brokers, operators, help desk personnel, back-office personnel. In one embodiment, the data is cached for performance reasons and the data is synchronized from the TPF **156** source.

The Trading Session Service module **145** maintains all business day and trading session-related information and manages the different states of a trading session, e.g. open, closed, and halted. Products that are processed/traded in each trading session are also kept at this service. In order to perform these responsibilities, the Product Service module **144** downloads trading session and product information from TPF **156**, as well as monitor events that affect products traded within a session.

The Product State Service **146** is responsible for coordinating product state changes for all products, e.g. pre-opening, opening, trading, halting, closing, and post-closing. It works closely with the Broker Service **230** to insure that state changes occur in a timely fashion. The service **146** monitors events that affect products traded, such as monitoring the underlying market to detect when the primary exchange opens, closes or halts trading a product. The Product Configuration Service **147** is responsible for providing the location of where a product is processed/traded. This information is primarily used to route product-specific requests (e.g. orders) for processing. The Order Status Service **148** provides subscription and notification services related to orders (i.e., fill reports, cancel reports, order accepted by book, etc.).

The Quote Status Service module **149** provides subscription and notification services related to quotes (i.e. fill reports, deletion reports, etc.) The service **149** preferably replaces the use of event channels for quote status reporting, providing a more secure mechanism for status delivery. The Market Data Service **150** maintains a current snapshot of market data, in addition to publishing market summary data. The module also provides an interface to clients to query historical market data.

The Best Quote module **151** is responsible for calculating the market best (aggregate quantities of buy and sell orders at the best price) for each product and sending them to TPF **156** (which in turn forwards them to the Options Price Reporting Authority) for public dissemination. In addition, it is responsible for calculating and disseminating the National Best Bid Offer (NBBO). In order to provide this information, the Best Quote module **151** subscribes to the event channel referred to herein as the Best of the Rest channel to obtain the current best quote from competing exchanges. The Best Quote module **151** then determines the source of the NBBO, whether it is from the present exchange or a competitor, and publishes the results to the Best Quote event channel, of which the TPF Adapter **152** is a subscriber.

Referring now to FIG. **2**C, the External Integration Services module **133** includes adapters **152**, **153**, **154**, and **155**, that map the interaction paradigms of external systems to the ones in the system **100** architecture. The adapter modules "adapt" (or "wrap") the native legacy interfaces to interfaces appropriate in the SBT environment. The TPF (Transaction Processing Facility) module **152** contains the adapter to allow SBT and TPF **156** to interact. TPF data is received, remoduled, and broadcast/delivered to the appropriate components within SBT. Conversely, SBT data is received, either through direct invocation or event consumption, remoduled, and sent to TPF **156** using its native interface.

The Membership Adapter **154** translates requests for member information received from SBT components into requests to the Membership System **159** and returns the results after reformatting.

The TIPS Adapter **155** subscribes to TIPS **157** to receive the external market data needed in the SBT environment, including underlying market data and the Best of the Rest of options listed in SBT. The Events Service (FIG. **2**D) notifies the TIPS Adapter **155** of consumer subscriptions so that it can propagate these subscriptions back to TIPS **157**. Once subscribed, the TIPS Adapter **155** reformats the market data received from TIPS **157** and publishes it for consumption by SBT components. Another responsibility of this adapter **155** is to publish underlying product state events when external markets change their states, for instance when they open, halt, close, etc.

The Trade Match Adapter **153** receives SBT data and forwards it to TM **158**. The TM Adapter **153** handles the following data flows: Trade Report (SBT to TM)—SBT reports all the parties to a trade to TM **158**.

Referring now to FIG. **2**D, the Infrastructure Services module **134** contains commercial "off-the-shelf" software and extended infrastructure services that provide enterprise-wide support to various other external systems. One mechanism by which the SBT system components interact with each other is by supplying and consuming events, implemented as a publish/subscribe pattern. The following list provides a brief description of the event flows/notification services (messaging services) shown in FIG. **2**D.

RFQ—the Market-maker (MM) Quote Service supplies RFQ events consumed by the Market-Maker Application.

BBBO—the Order Book supplies Book Best Bid Offer (BBBO) events consumed by the Best Quote Service.

NBBO—the Best Quote Service supplies National Best Bid Offer (NBBO) events consumed by the Trader Application, and Market Data Service.

Current Market—the Best Quote Service supplies Current Market Best events, containing a product's best quote, consumed by the Market Data Service and Trader Application. The best quote indicates if the exchange has the best quote.

Best of the Rest—the TIPS Adapter component supplies best-of-the-rest events consumed by the Best Quote Service.

Last Sale—the Trade Service supplies last sale events consumed by the Market Data Service **150** and TPF Adapter **152**.

Last Sale Summary—the Market Data Service **150** component supplies last sale summary events consumed by the Trader application.

Logging—the Logging Service Proxy component supplies Log Service events consumed by the Log Service component.

System Management—the Foundation Framework supplies System Management events consumed by the System Management component.

Instrumentation—the Instrumentation Service component supplies Instrumentation events consumed by both the System Management component and the Log Service component.

Underlying Ticker—the TIPS Adapter supplies Underlying ticker events (prices, quotes, last sales, news alerts) consumed by the Trader Application and the Product Service.

Underlying Recap—the TIPS Adapter supplies Underlying summary events (high and low prices, volume) consumed by the Market Data Service and Trader Application.

Trade Report—the Trade Service supplies Trade Report events consumed by the TPF Adapter **152**.

Product Status—the Product Service **144** and Product State Service **146** supply Product Status events (State, Price Adjustment, and Update) events consumed by the Trader application, Order Handling Service **220**, and TPF Adapter **152**.

Trading Session Status—the Trading Session Service **145** supplies Trading Session State events consumed by the Operations Application **140** and Help Desk application **160**.

End of Session Summary—the Trading Session Service supplies End of Trading Session Status events.

Opening Price—The Broker Service module **230** supplies Opening Price events consumed by the Trader Application **136**.

Control—the Operations **140** and Help Desk **160** applications supply Control events, possibly through the System Management component, consumed by Business Services **132** and External Integration Services **133** components.

Order Status—the Order Handling Service **220** (Order) supplies Fill Report, Cancel Report, Updated Order, New Order, and Order Accepted by Book events consumed by the Order Status Service **148**, and TPF Adapter **152**.

Quote Status—the MM Quote Service **240** (Quote) supply Fill Report, and Delete Report events consumed by the Quote Status Service **149**.

In accordance with a preferred embodiment, there are four major tiers of the application software. The business services **132** handle all the SBT order matching, execution and reporting functionality. It provides the repository for all SBT information data. The application services **210** handle the application presentation and act as the application front end to the business services. Different views of the business services **132** and collaboration of business objects are grouped together and are presented to the user based on logon authentication and authorization level. The two tiers communicate to each other by two supported tiers: the infrastructure services **134** and external integration services **133**. The infrastructure services **134** provide a seamless integration between the application services **210** and business services **132**. The external integration services **133** provide the access to the external system.

With reference to FIG. **3**, a sequence diagram **200** for a preferred embodiment of the automated exchange system **100** is shown. The system **100** includes a client application server **210**, an order handling service module **220**, a broker service module **230**, a quote service module **240**, a user service module **260**, and quote objects **250** and **252**. The service modules **220**, **230**, **240**, **260** and objects **250**, **252** are preferably software modules running on clusters **102**, or on one or more interconnected computers. The software modules are preferably written in an object-oriented programming language and are compiled to run on the clustered computers **102**. Preferably, the software utilizes the C++ language, the Java programming language, or other object-oriented language. Alternatively, any suitable software language may be used to implement the system, as will be understood by one of ordinary skill in the art. The modules also interact with a database program used for storing data and other system and user information. In the preferred embodiment an Oracle database system is used.

The client application server **210**, as discussed above, runs on client servers **110**, **112**, and provides an interface to one or more clients. The client server **110**, **112** may include one or more application modules, depending upon the intended users of the servers **110**, **112**. For example, the client servers **110**, **112** preferably include at least one of a market-maker application, a trader application, a back-office application, or a member interface. The client servers **110**, **112** also preferably utilize a user authentication and role-based security model to control access to the various application modules.

The client server **110**, **112** may also include modules such as a help desk application, an operations application, and a Clearing Firm Broker (CFB) module. The CFB module may be configured to allow a Clearing Firm to set maximum volume limits on a per-class basis. The Help Desk module is preferably enabled for use on client servers that provide connectivity to exchange management personnel. The Help Desk provides a utility to force a user to logout of the system.

The order handling service **220** forwards orders to the appropriate broker service module **230** that handles the class of options to which the individual orders relate. If the broker service module **230** cannot execute the order immediately, it routes it to the order book service module, which maintains the current state of all pending orders and quotes. The order handling service module **220** receives order information from various sources, including brokers, traders, market-makers, etc. The orders may enter the system from a client application server **210** or through an alternative interface such as TFP adapter **152**, which is a connection that allows a pre-existing automated order handling system such as TPF system **156**, to access the present system.

The broker service module **230** is responsible for executing various types of orders, including limit, market, all or none, fill or kill, immediate or cancel, stop, stop limit, and spread orders. Preferably, there are numerous broker service modules **230** running on the exchange server **104**, or on the interconnected computers in the cluster **102**, where each broker service module **230** handles trades for a subset of products offered by the exchange. For example, there is preferably a broker service module **230** for each class of option contracts. The broker service module **230** thus matches incoming orders to other orders or to quotes supplied by market-makers to complete a trade, indicated by line **282** in FIG. **3**.

The broker service module **230** also receives quotes from the quote service **240**, discussed below. The broker service module **230** attempts to execute a trade **282** by matching incoming quotes to orders or to other quotes stored by the order book service module **142** in the order book. Note that for purposes of trade execution **282**, quotes are treated by the exchange system **100** as if they were orders. Thus, when the broker service module **230** receives a quote that it cannot match to an existing order or quote, it sends the quote to the order book for storage with other unfilled quotes and orders. Preferably, quotes differ from regular orders in that a quote may be two sided, having a bid and an offer price, and that each market-maker may only have one quote per product in the system.

To facilitate the order matching process of trade execution **282**, the broker service module **230** has direct access to orders stored in the order book by the order book service module **142**. Preferably, when the incoming order is matched to an existing quote supplied by the quote service module **240**, the broker service module **230** provides the quote service module **240** with details of the trade.

The quote service module **240** manages the quotes supplied by market-makers via client application service module **210**. The quote service module **240** submits the quotes to the broker service module **230** for execution. The quote service module **240** ensures that each individual market-maker has only one quote per product in the system at any

given time. When a market-maker enters a new quote on a product for which he already has an outstanding quote, the quote service module preferably determines whether there is already an existing quote in the system for that market-maker and, if so, informs the broker service module **230** that the pre-existing quote is to be cancelled. The quote service module **240** submits the new quote to the broker service module **230** only after it has received acknowledgement from the broker service module **230** that the pre-existing quote has been cancelled.

The broker service module **230** issues fill reports to notify various other modules, and ultimately the trading entities, that the trade was executed. Upon notification of a fill **284** from the broker service module **230** (or the order book module), the quote service module **240** informs the quote object **250**. In turn, the market-maker is notified of the fill via the exchange's reporting system. The quote service module **240** also cancels or updates a market-maker quote upon receiving a request from the originating market-maker by submitting the request to the broker service **230**. The quote service module performs this by first informing broker service module **230** that the pre-existing quote has been cancelled. The broker service module **230** then removes the quote from the order book and confirms to the quote service **240** that the quote has been cancelled. The quote service **240** then submits the new quote (if one exists) to the broker service module **230**.

With respect to FIG. **3**, a preferred sequence of events and messages will be described. Market-Makers log into a client application server module **210** and access the user service module **260**. The market-maker communicates with the user service module **260** through a terminal, such as a workstation or wireless handheld unit. As shown by line **270**, trading parameters, or quote parameters, are sent to the user service module **260**. Upon initialization of the quote service, or upon login of a new market-maker, various trading parameters are provided to the quote service module **240** as shown by line **271**. The trading parameters may include a risk threshold, a quote regeneration indicator, a quote regeneration increment, a quote modification indicator, and a quote modification increment. The parameters may include numerous sets of thresholds, indicators, and increments, preferably one such set for each class for which the market-maker is providing quotes.

The quote service module **240** receives quotes from market-makers as shown by line **272**, and provides these quotes to the quote objects **250**, **252**, as shown by update lines **273**, **274**, and to the broker service module **230** as shown by line **276**. As mentioned above, the quote service module **240** will not forward updated quotes (as opposed to new quotes) to the broker service module **230** before first canceling old quotes.

Orders received by the client application server **210** are routed to the order handling service **220** as shown by line **278**. The order is then forwarded to the appropriate broker service **230** as shown by line **280**. The broker service module **230** attempts to execute every order or quote received with the best order (or quote) in the book as shown by line **282**. When a trade is executed, a fill report is issued to the quote service module **240** as shown by line **284**. The quote service module **240** then analyzes the trade and determines whether the market-maker's risk threshold has been exceeded, as shown by line **286**. The threshold test will be described in further detail below. A fill report is sent to the quote object **250** as shown by line **288**. The quote object **250** then informs market-maker of the fill through the use of a trade report service module (not shown).

In addition, at steps **286** and **287**, the quote service module may modify quotes in response to the trade in accordance with the market-maker's trading parameters, as discussed below. The quote service module then reports the new quotes to the broker service module **230** as shown by line **290**. The broker service **230** acknowledges the quote updates as shown by line **292**. If the broker service **230** has already processed additional trades against the original quote, then the broker service module **230** would respond with a "too late to cancel" message. Once the update acknowledge has been received, the quote service module **240** updates the quote objects **250**, **252**, as shown by lines **294**, **296**. The quote objects then inform the market-maker that its quotes have been updated.

Risk Measurements and Risk Thresholds

In a preferred embodiment of the automated trading system **100** having integrated order modification and quote risk monitoring, the aggregate risk of a market-maker's recent trades is calculated after each trade. The measurement preferably includes either calculating an equivalent stock position, i.e., a net delta (by, for example, summing delta values for all contracts traded by the market-maker associated with the option series in the class), or calculating a net gamma, theta, or vega.

In particular, the aggregate risk measurement is preferably the net delta of all the trades for a specific market-maker or a designated group of market-makers in a given class in a given period of time. The quotes in a given class submitted by a market-maker (or a group of market-makers) are referred to herein as a quote group. The rules for delta calculations are as listed below:

Calls (delta value Δ is positive)
Market-maker selling
Market-maker position will be Negative Delta
Market-maker buying
Market-maker position will be Positive Delta

Puts (delta value Δ is negative)
Market-maker selling
Market-maker position will be Positive Delta
Market-maker buying
Market-maker position will be Negative Delta

The aggregate risk net delta is defined as:

$$\Delta_{NET} = \sum_i S_i \cdot \Delta_i \cdot U_i \cdot K_i, \quad (1)$$

which is the summation for i trades of the product of S, the sign of the trade, where S is positive when a market-maker buys and negative when a market-maker sells, Δ (delta), which is rate of change of the price of the individual series with respect to the stock, and ranges from −1.0 to 0 for puts and 0 to 1.0 for calls, U, which is the unit of trade, i.e. the number of shares, and K, the number of contracts traded by the market-maker.

The aggregate risk measurement is preferably based on the net delta Δ_{NET} for the entire class of options, which is the sum of all the deltas for a given market-maker's trades in all series of a class. The delta contribution for each trade is calculated every time a trade occurs for any series in the class. The aggregate risk is then calculated by summing delta contributions from only the most recent trades. The values for the theoretical deltas Δ_i are preferably obtained by

an autoquote system (not shown) associated with the exchange system **100**, and more particularly with the business services package **132**.

Autoquote systems provide pricing information, and specifically theoretical delta values Δ_i, using well-known algorithms that utilize standard parameters, as is understood to those of skill in the art. Most of the parameters associated with calculating an individual series delta value are objective data, such as the date, strike price, the price of the underlying security, etc. Other autoquote parameters have acceptable default values that may be used, such as using the broker loan rate for the interest rate, etc. One parameter that may be more subjective among individual market-makers is the volatility parameter. Thus, the system **100** may be designed such that each quote submitted by a market-maker includes a volatility field to be used by the system in determining the individual theoretical delta value Δ_i. The theoretical delta value Δ_i may then be calculated either as part of the threshold test, or may be periodically updated at a rate sufficient to provide a fairly accurate delta value Δ_i. In this way, the system **100** provides the market-maker with further control over the quote risk monitoring system.

Because the exchange quote modification service is intended to address increased risks associated with a rapid sequence of trades, older trades need not be included because the market-maker has had an opportunity to manually intervene and modify his quotes. Thus, the aggregate risk measurement may be based on the last N trades, where N is a trading parameter specified by the market-maker, or may be based on trades occurring within a specific time frame. The duration of the time frame may be specified by the market-maker by providing a time window parameter t_K, which is included as a trading parameter. Alternatively, a default value for t_K may be used.

Alternatively, the risk threshold and risk measurement may include an aggregate gamma measurement. Gamma is known to those of skill in the art to be the rate of change of the delta parameter with respect to the rate of change of the underlying security, such as the stock. An aggregate gamma measurement provides an indication of the rate at which an aggregate delta measurement will change. Net gamma values are negative when a market-maker is a net seller of contracts, and positive when a market-maker is a net buyer of contracts. As a further alternative, either theta, which is the rate at which option prices change over time, or vega, which is the change in an option contract that results from a change in its volatility, may be included.

The market-maker may provide a single threshold Δ_{NETMAX} such that if the absolute value of the aggregate risk exceeds the threshold, then the quotes are modified according to the rules set forth below. The market-maker may also provide positive and negative thresholds Δ^{+}_{NETMAX} and Δ^{-}_{NETMAX} to accommodate a market-maker's pre-existing risk bias.

In an alternative preferred embodiment, the market-maker's risk is determined by calculating the net contract volume traded within a specified time. The net contract volume K_{NET} may be calculated by using equation (1) above, with the exception that the delta value is replaced by the sign of Δ, or ±1, where calls are positive 1, and puts are negative 1:

$$K_{NET} = \sum_i S_i \cdot \text{sign}(\Delta_i) \cdot U_i \cdot K_i, \text{ for each trade, } i. \quad (2)$$

The result is that the volume of each trade is treated as a positive or negative value, depending upon the nature of the trade-selling calls and buying puts have negative contributions, and buying calls and selling puts have positive contributions. The sum of the trades is then calculated to provide a net difference between the number of short calls plus long puts and long calls plus short puts. Thus, the market-makers may specify a threshold in terms of a maximum net contract volume offset, K_{NETMAX} (or positive and negative thresholds K^{+}_{NETMAX} and K^{-}_{NETMAX} to accommodate a market-maker's pre-existing risk bias). As stated above, the system may be configured to also allow the market-makers to specify a time window parameter t_K that specifies which trades should be included in the risk calculation. Thus, only the contracts K that have been executed within the previous t seconds will be included in equation 2. Alternatively, the system may be configured to specify i, the number of previous trades to include in the risk calculation.

In still further embodiments, the aggregate risk measurement may be simplified by calculating the total number of put or call contracts (or deltas) that have been sold or bought within a given time frame or within that last N trades. Thus, for example, when a market-maker has just sold a put, the quote service module **240** may calculate the total number of puts sold (or the delta due to all the puts sold) within the given trading window and compare it to a threshold. If the next trade is a call purchase, then the system would calculate the contracts or deltas for the calls purchased. Thus, if any of the four aggregate volume quantities (buying calls, selling calls, buying puts, selling puts) exceeds a threshold (within a certain time period, or certain number of trades), the quote modification module **340** modifies the quotes appropriately. Alternatively, the quote service module **240** may calculate the total calls bought plus puts sold, and the total calls sold plus puts bought, and notify the quote modification module **340** if either of these aggregate values exceeds the threshold. As a further alternative, the quote service module may use a weighting scheme to calculate aggregate values described above. Specifically, in-the-money options (options with intrinsic value) may be weighted more heavily than at-the-money or out-of-the-money options. In one preferred method, the in-the-money options are weighted with a factor of two, at-the-money options are weighted with a factor of one, and out-of-the-money options are weighted by a factor of one half. These simplified risk measurement and threshold tests perform adequately due to the nature of trading activities that typically result in large risk exposure.

It should also be noted that the market-makers may be grouped together for purposes of risk exposure analysis. That is, the total risk may be calculated based on the trades of one or more market-makers. The market-makers provide a group identification parameter(s) indicating which other market-makers' trades should be included in the risk calculation. In this manner, market-makers acting in concert on behalf of a single organization may coordinate their quote modification.

Automatic Quote Modification

The quote service module **240** of the exchange system **100** includes a quote modification service module **340**. The quote modification service module **340** may be implemented as part of the quote service module **240**, or may be a separate service module. It may also take the form of a separate quote factory module for generating new instantiations of quote objects. The quote modification service module **340** performs quote modification by preferably automatically revising, canceling, or regenerating quotes. The quote modifica-

tion service module **340** resides on the exchange system computer **104**, **106**, or computer cluster **102**. The quotes are modified by the exchange system in an automatic manner that does not require further input from the market-maker in the form of quote cancellation requests and submission of new quotes by the market-maker or his computer. In this way, the exchange system performs quote modification immediately and without the transmission delays inherent in communication systems and without delays associated with processing queued cancellation requests received from a remote location.

If the quote service module **240** determines that the threshold(s) have been exceeded, the quote service module **240** determines revised quotes and forwards them to the broker service module **230** and the quote objects **250**, **252**. The revised quotes can take numerous forms. In a first embodiment, the quote service module **240** revises quotes by canceling all outstanding quotes in the class, thereby preventing any further trades from executing and giving the market-maker time to provide revised quotes. In this embodiment, the quote service module **240** sends quote update messages **290** in the form of cancellation messages to the broker service module **230**. The broker service **230** then removes those quotes from the electronic book. Because the threshold test is performed by the exchange system **100** after each trade, the cancellation messages are therefore preferably processed before any further trades can be executed. This is possible because the cancellation requests are not sent from a remote node on a wide area network, such as a market-maker's computing platform, but are generated by the exchange system **100**. This provides the advantage of eliminating a cancellation message queue, as would be used when sending cancellation requests from a remote node, thereby improving quote update times and providing risk management.

In a second embodiment, the quote service module **240** revises quotes by reducing the quantity associated with the existing quotes in the class thereby reducing the amounts of potential further trades and reducing the market-maker's exposure to more risk. The market-maker may specify the amount of the volume decrease by way of an increment value. In this embodiment, the quote service module **240** sends quote updates **290** by first sending quote cancellation messages to the broker service module **230**, and after acknowledgment, sending the revised quotes to the broker service module **230** for execution or booking. Again, because the threshold test is performed by the exchange system **100** after each trade, the cancellation messages are therefore preferably processed before any further trades can be executed. As above, this is possible because the cancellation requests are not sent from a remote node on a wide area network, such as a market-maker's computing platform, but are generated by the exchange system **100**.

In a third embodiment, the quote service module **240** revises quotes by decreasing the bid and offer values of some quotes and increasing others in an attempt to cancel some of the risk already assumed by the market-maker. The quote service **240** does this by automatically adjusting quotes to favor trades that will tend to provide offsetting risk. Specifically, if the threshold (K_{NETMAX} or Δ_{NETMAX}) has been exceeded by a high positive-valued net delta (or K), then the net delta (or K) may be offset by trades having a negative delta (or K). As set forth above, those trades would include selling calls and buying puts. Similarly, if the threshold has been exceeded by a high negative-valued net delta (or K), then the aggregate risk may be offset by trades having a positive delta (or K), or by selling puts and buying calls. Of course, to produce the desired trades, the lowering of offer values of quotes will tend to result in more selling activity by the market-maker, and the raising of bid values will result in more buying activity by the market-maker. In this embodiment, the modification increment is specified by an increment value. As in the previous embodiment, the quote service module **240** sends quote updates **290** by sending quote cancellation messages to the broker service module **230**, and after acknowledgment, sending the revised quotes to the broker service module **230** for execution or booking. Again the automated risk monitoring system and quote modification service of system **100** provides advantages in that the market-maker need not cancel previous quotes and submit new quotes while still being exposed to the possibility of further trades being executed.

The quote service **240** may also modify quotes by regenerating the just-filled quote. This may be performed even if the market-maker's risk threshold has not been exceeded. The market-maker is able to specify quote regeneration parameters via client application server **210** that are stored in the user service module **260**. The parameters specify which products are enabled for quote regeneration, and the extent to which the quotes are to be regenerated. The market-maker may therefore specify, on a product-by-product basis, how many times the quotes are to be regenerated after each quote has been filled. This is referred to herein as the regeneration number parameter. The market-maker may also specify whether the regenerated quotes are to have the same bid and offer values, or are to be backed-off from the previous trade. This parameter is referred to herein as the regeneration increment. That is, for a two-sided quote, if the market-maker has just sold a quantity of contracts at his offer price, the regenerated quote may have a higher offer value. Preferably the bid value is also raised accordingly to maintain a desired or required spread in bid and offer quotes. If, on the other hand, the market-maker has just bought a quantity of contracts at his bid price, the regenerated quote may have a lower bid value. The market-maker also has the option of specifying on a per-class basis the values of the regeneration number parameter and the regeneration increment parameter. The quote regeneration is preferably not performed if the market-maker risk threshold has been exceeded, unless the market-maker has specifically selected quote revision in the event the risk threshold has been exceeded.

With reference to FIG. **4**, the method of quote modification **300** will be described. Upon execution of a trade at step **310**, the quote service module **240** at step **320** checks to see whether the individual market-maker's risk threshold has been exceeded. As mentioned above, the risk measurement and threshold test may be performed using a variety of methods, and certain market-makers' trading activities may be combined for the purposes of risk exposure. If the threshold has not been exceeded, then at step **330** the quote service module **240** preferably checks to see whether the market-maker whose quote has been executed has indicated the desire to have his quotes regenerated. If not, then the process has completed. In the event that the result of either inquiry **320**, **330** is affirmative, then the quote service **240** modifies the quotes with the quote modification module **340** as described above.

Quote modification module **340** includes quote regeneration module **350** and cancel or revise quote module **360**. As mentioned above, the quote modification module **340** may be integral to quote service module **240**, or may be included in a quote factory module, or may be a separate service module. The quotes are regenerated, cancelled, or revised,

for example as described above, and submitted as shown in step **370** to the broker service module **230** for execution.

Preferred embodiments of the present invention have been described herein. It is to be understood, of course, that changes and modifications may be made in the embodiments without departing from the true scope of the present invention, as defined by the appended claims. The present embodiment preferably includes logic to implement the described methods in software modules as a set of computer executable software instructions. A Central Processing Unit ("CPU"), or microprocessor, implements the logic that controls the operation of the transceiver. The microprocessor executes software that can be programmed by those of skill in the art to provide the described functionality.

The software can be represented as a sequence of binary bits maintained on a computer readable medium including magnetic disks, optical disks, and any other volatile or (e.g., Random Access memory ("RAM")) non-volatile firmware (e.g., Read Only Memory ("ROM")) storage system readable by the CPU. The memory locations where data bits are maintained also include physical locations that have particular electrical, magnetic, optical, or organic properties corresponding to the stored data bits. The software instructions are executed as data bits by the CPU with a memory system causing a transformation of the electrical signal representation, and the maintenance of data bits at memory locations in the memory system to thereby reconfigure or otherwise alter the unit's operation. The executable software code may implement, for example, the methods as described above.

It should be understood that the programs, processes, methods and apparatus described herein are not related or limited to any particular type of computer or network apparatus (hardware or software), unless indicated otherwise. Various types of general purpose or specialized computer apparatus or computing device may be used with or perform operations in accordance with the teachings described herein.

It should be understood that a hardware embodiment may take a variety of different forms. The hardware may be implemented as an integrated circuit with custom gate arrays or an application specific integrated circuit ("ASIC"). Of the course, the embodiment may also be implemented with discrete hardware components and circuitry. In particular, it is understood that the logic structures and method steps described herein may be implemented in dedicated hardware such as an ASIC, or as program instructions carried out by a microprocessor or other computing device.

The claims should not be read as limited to the described order of elements unless stated to that effect. In addition, use of the term "means" in any claim is intended to invoke 35 U.S.C. §112, paragraph 6, and any claim without the word "means" is not so intended. Therefore, all embodiments that come within the scope and spirit of the following claims and equivalents thereto are claimed as the invention.

We claim:

1. A method of modifying quotes in an automated exchange trading system comprising the steps of:

receiving orders and quotes, wherein specified ones of said quotes belong to a quote group, and wherein said specified ones of said quotes have associated trading parameters comprising a risk threshold;

generating a trade by matching said received orders and quotes to previously received orders and quotes;

storing each of said orders and quotes when a trade is not generated;

determining whether a quote having associated trading parameters has been filled as a result of the generated trade, and if so, determining a risk level and an aggregate risk level associated with said trade;

comparing said aggregate risk level with said risk threshold; and,

automatically modifying at least one of the remaining said specified ones of said quotes in the quote group if said threshold is exceeded.

2. The method of claim **1** wherein the quotes are stored in a quote data structure containing a plurality of quotes fields and at least one risk threshold field.

3. The method of claim **2**, wherein the plurality of quote fields comprises a bid quote field and an offer quote field.

4. The method of claim **2**, wherein the data structure further comprises a group indicator field.

5. The method of claim **2**, wherein the data structure further comprises a quote modification increment field.

6. The method of claim **2**, wherein the data structure further comprises a quote regeneration increment field.

7. The method of claim **2**, wherein the data structure further comprises an owner field.

8. A method of modifying quotes in an automated exchange trading system that receives orders and quotes from remote computers, matches the orders and quotes to generate trades, and stores orders and quotes that are unmatched, comprising the steps of:

receiving trading parameters comprising a risk threshold;

associating said trading parameters with specified ones of received quotes;

determining whether a quote having associated trading parameters has been filled as a result of a generated trade, and if so, determining a risk level and an aggregate risk level associated with said trade;

comparing said aggregate risk level with said risk threshold; and,

automatically modifying at least one of the specified ones of received quotes if said threshold is exceeded.

9. The method of claim **8** wherein the step of determining a risk level comprises calculating a delta value for the generated trade.

10. The method of claim **8** wherein the step of determining a risk level comprises calculating a trading volume for the generated trade.

11. The method of claim **8** wherein the step of determining an aggregate risk level comprises determining a net delta.

12. The method of claim **8** wherein the trading parameters further comprise a time duration, and wherein the step of determining an aggregate risk level comprises summing the deltas from trades involving at least a subset of quotes contained in said quote group that were executed within the time duration.

13. The method of claim **8** wherein the trading parameters further comprise an integer N, and wherein the step of determining an aggregate risk level comprises summing the deltas from the most recent N trades involving at least a subset of quotes contained in said quote group.

14. The method of claim **8** wherein the step of determining an aggregate risk level comprises determining a net contract volume.

15. The method of claim **8** wherein the step of determining an aggregate risk level comprises determining a weighted sum of contract volumes.

16. The method of claim **8** wherein the step of determining an aggregate risk level comprises determining an aggregate volume quantity.

17. The method of claim 8 wherein the step of automatically modifying at least one of the specified ones of said received quotes comprises canceling all said specified ones of said received quotes.

18. The method of claim 8 wherein the step of automatically modifying at least one of the specified ones of said received quotes comprises reducing the quantity associated with the specified ones of received quotes.

19. The method of claim 8 wherein the step of automatically modifying at least one of the specified ones of said quotes comprises revising at least one of the bid and offer values of each of the specified ones of received quotes.

20. The method of claim 8 wherein the trading parameters comprise a positive risk threshold and a negative risk threshold.

21. The method of claim 20 wherein the step of comparing the aggregate risk level with the risk threshold comprises comparing the aggregate risk level to the positive risk threshold if the aggregate risk level is positive, and comparing the aggregate risk level to the negative risk threshold if the aggregate risk level is negative.

22. The method of claim 8 wherein the step of comparing the aggregate risk level with the risk threshold comprises comparing the absolute value of the aggregate risk level to the risk threshold.

23. The method of claim 8 wherein each of the specified ones of received quotes are associated with one of a first subgroup and second subgroup, and wherein the step of automatically modifying at least one of the specified ones of received quotes in the quote group comprises reducing the offer values of the quotes in the first subgroup and raising the bid values of the quotes in the second subgroup.

24. The method of claim 23 wherein the first subgroup comprises quotes on call series options and the second subgroup comprises quotes on put series options, and wherein the aggregate risk is positive.

25. The method of claim 23 wherein the first subgroup comprises quotes on put series options and the second subgroup comprises quotes on call series options, and wherein the aggregate risk is negative.

26. The method of claim 23 where the amount of said reducing and raising is determined in response to a modification increment parameter.

27. The method of claim 8 further comprising the step of automatically modifying a quote comprises regenerating a quote having associated trading parameters that has been filled as a result of the generated trade.

28. The method of claim 27 wherein the step of regenerating a quote is performed utilizing a regeneration increment.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 7,356,498 B2
APPLICATION NO. : 09/475534
DATED : April 8, 2008
INVENTOR(S) : Ross G. Kaminsky et al.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

On the Title Page

On page 2, in column 1, line 8, under "U.S. PATENT DOCUMENTS", delete "5,744,877 A 4/1998" and substitute --5,774,877 A 6/1998-- in its place.

Signed and Sealed this

Second Day of December, 2008

JON W. DUDAS
Director of the United States Patent and Trademark Office

US007980457B2

(12) **United States Patent**
Kaminsky et al.

(10) **Patent No.: US 7,980,457 B2**
(45) **Date of Patent: Jul. 19, 2011**

(54) **AUTOMATED TRADING EXCHANGE SYSTEM HAVING INTEGRATED QUOTE RISK MONITORING AND INTEGRATED QUOTE MODIFICATION SERVICES**

(75) Inventors: **Ross G. Kaminsky**, Chicago, IL (US); **Richard A. Angell**, Evanston, IL (US); **Gordon D. Evora**, Chicago, IL (US)

(73) Assignee: **Chicago Board Options Exchange, Incorporated**, Chicago, IL (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 427 days.

(21) Appl. No.: **12/035,996**

(22) Filed: **Feb. 22, 2008**

(65) **Prior Publication Data**

US 2008/0208734 A1 Aug. 28, 2008

Related U.S. Application Data

(63) Continuation of application No. 09/475,534, filed on Dec. 30, 1999, now Pat. No. 7,356,498.

(51) **Int. Cl.**
G06F 17/00 (2006.01)
G06Q 40/00 (2006.01)

(52) **U.S. Cl.** ..... **235/375**; 705/36 R; 705/38

(58) **Field of Classification Search** ..... 235/375, 235/376, 380, 385; 705/35, 36 R, 37, 38, 705/39, 40, 41

See application file for complete search history.

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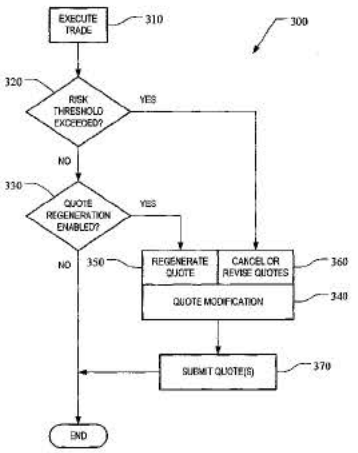
Primary Examiner — Andrew Joseph Rudy
(74) *Attorney, Agent, or Firm* — Brinks Hofer Gilson & Lione

(57) **ABSTRACT**

An automated trading exchange having integrated quote risk monitoring and quote modification services. An apparatus is implemented using at least one computer, having memory, and a processor. The computer is configured to receive orders and quotes, wherein specified ones of the quotes are contained in a quote group, and have associated trading parameters such as a risk threshold. Not all received quotes are required to have trading parameters as described herein. Preferably, the quote group contains all the quotes, or a subset of quotes, belonging to an individual market-maker for a given class of options contracts, or possibly the quotes of two or more market-makers that have identified themselves as belonging to a group for the purposes of risk monitoring and quote modification. The computer typically generates a trade by matching the received orders and quotes to previously received orders and quotes, and otherwise stores each of the received orders and quotes if a trade is not generated. The computer then determines whether a quote within the quote group has been filled as a result of the generated trade, and if so, determines a risk level and an aggregate risk level associated with said trade. The computer then compares the aggregate risk level with the market-maker's risk threshold, and if the threshold is exceeded, automatically modifies at least one of the remaining quotes in the quote group. The computer may also automatically regenerate quotes that have been filled.

7 Claims, 7 Drawing Sheets



EXHIBIT

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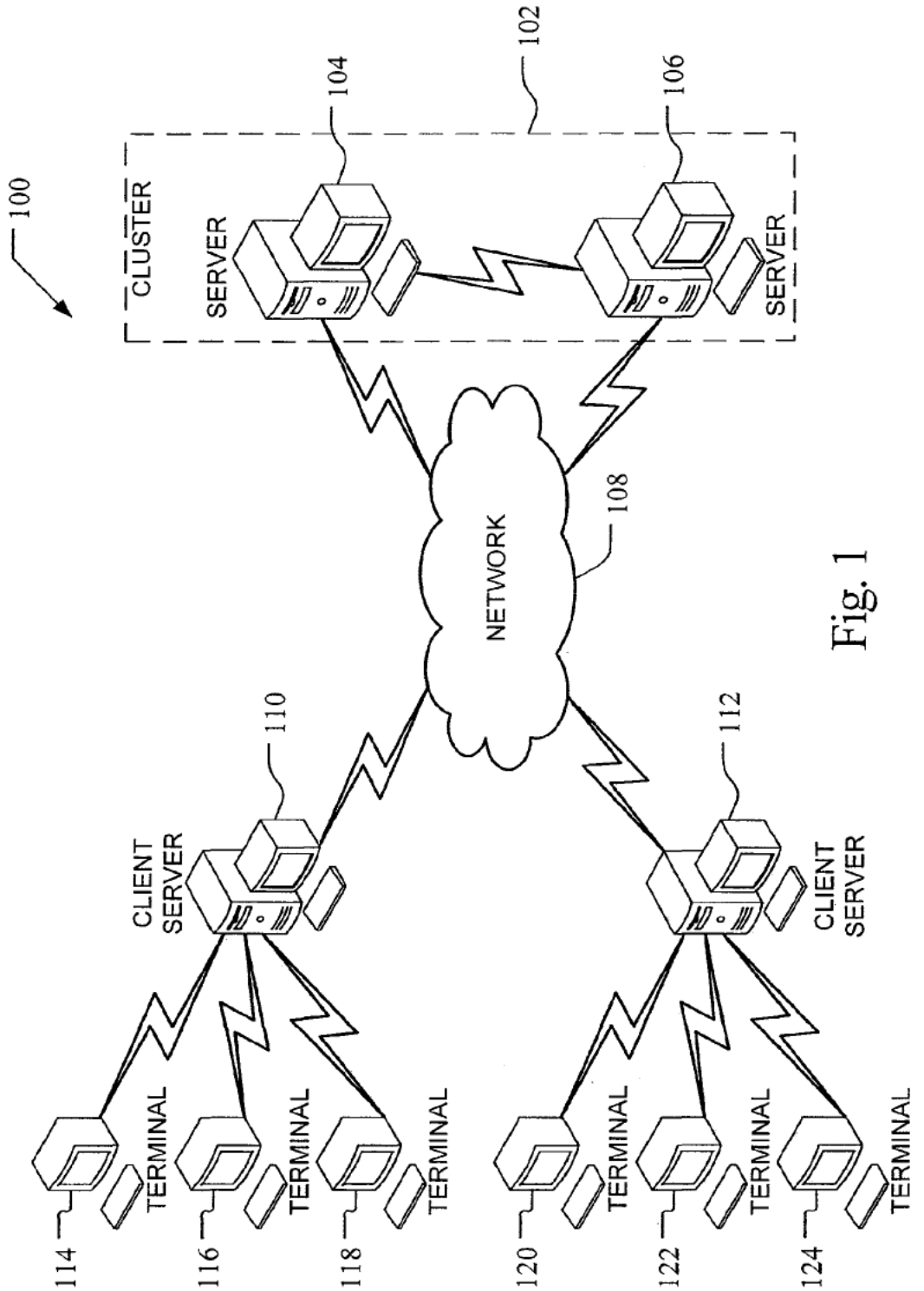

Fig. 1

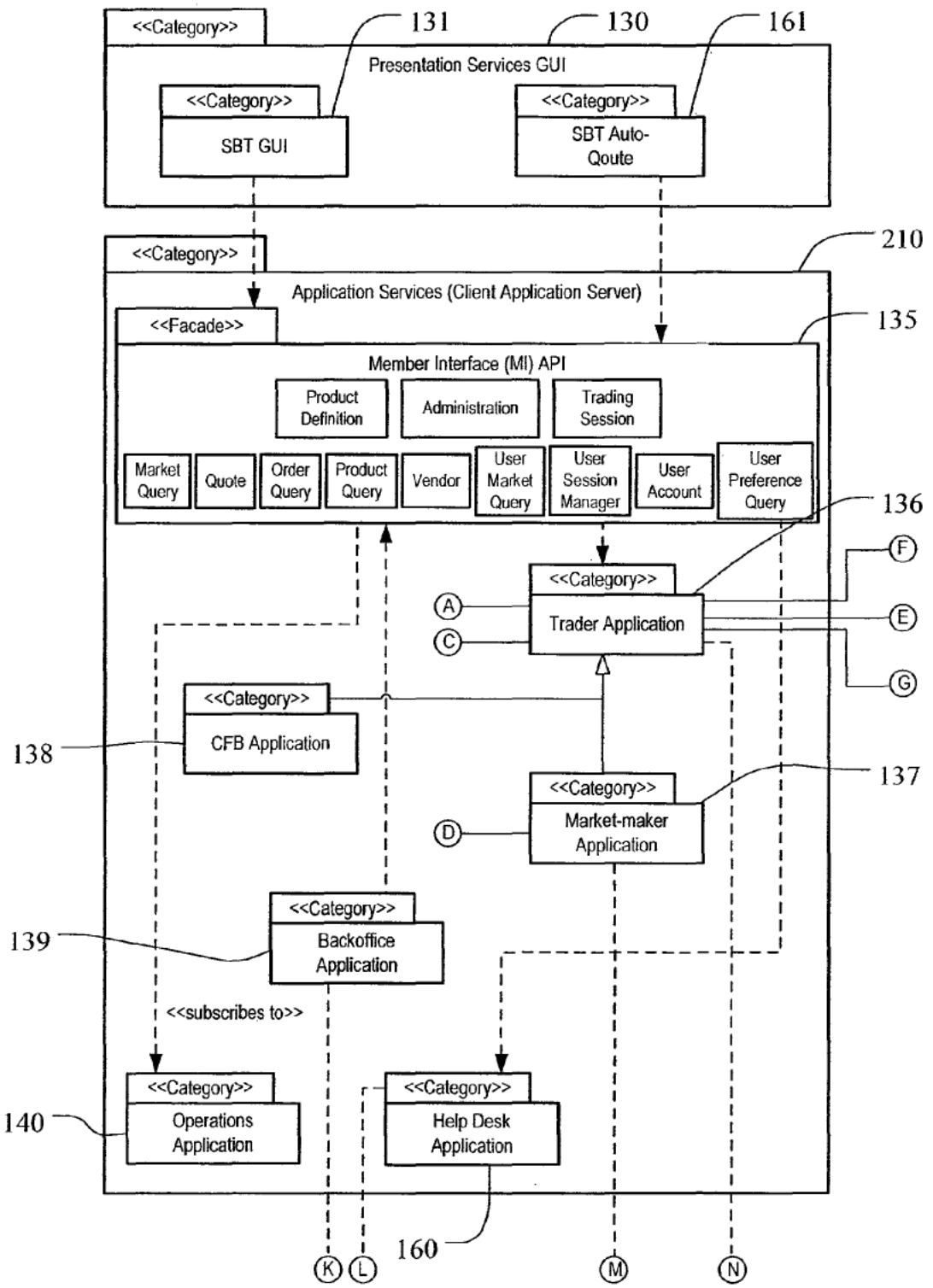
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Fig. 2A

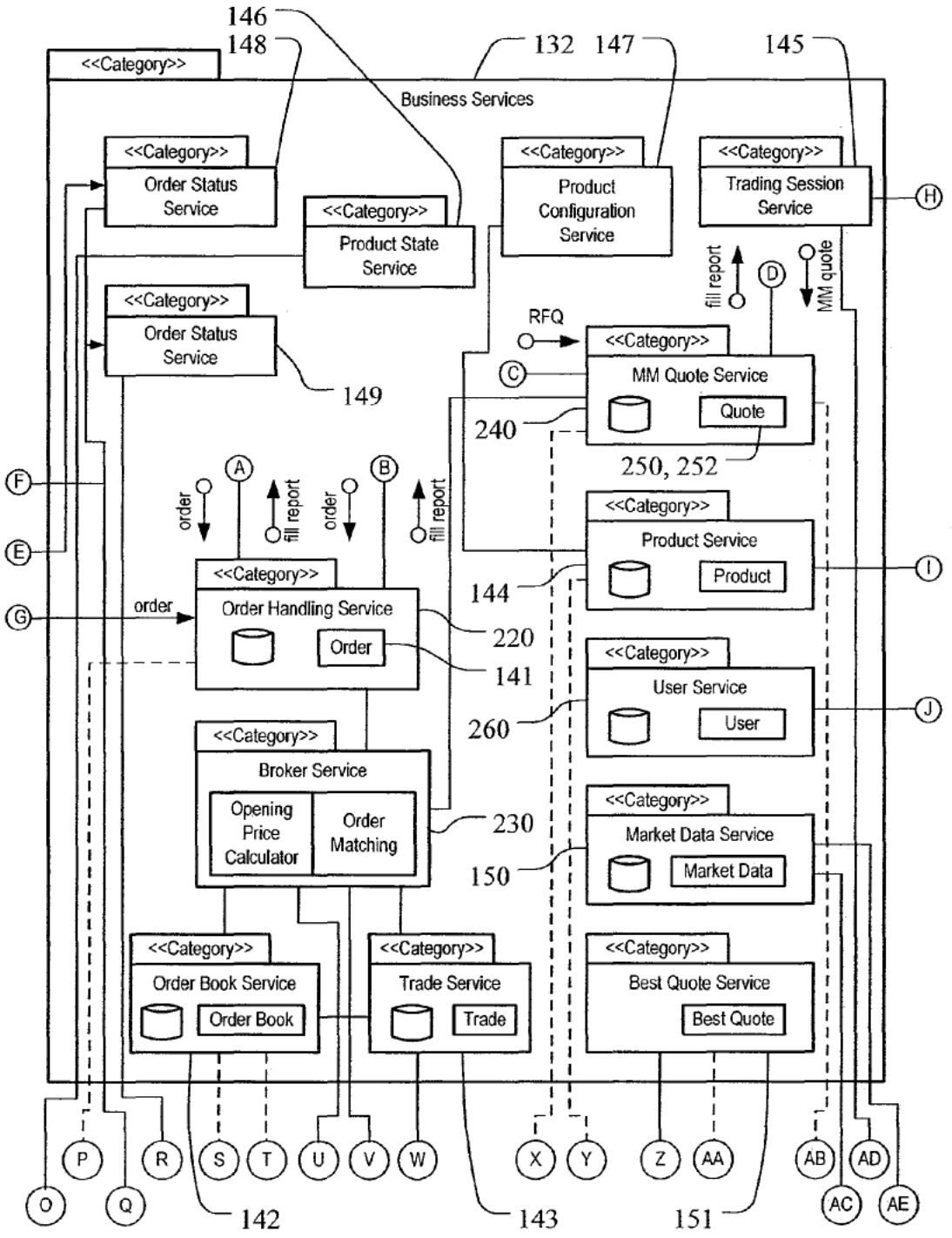
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Fig. 2B

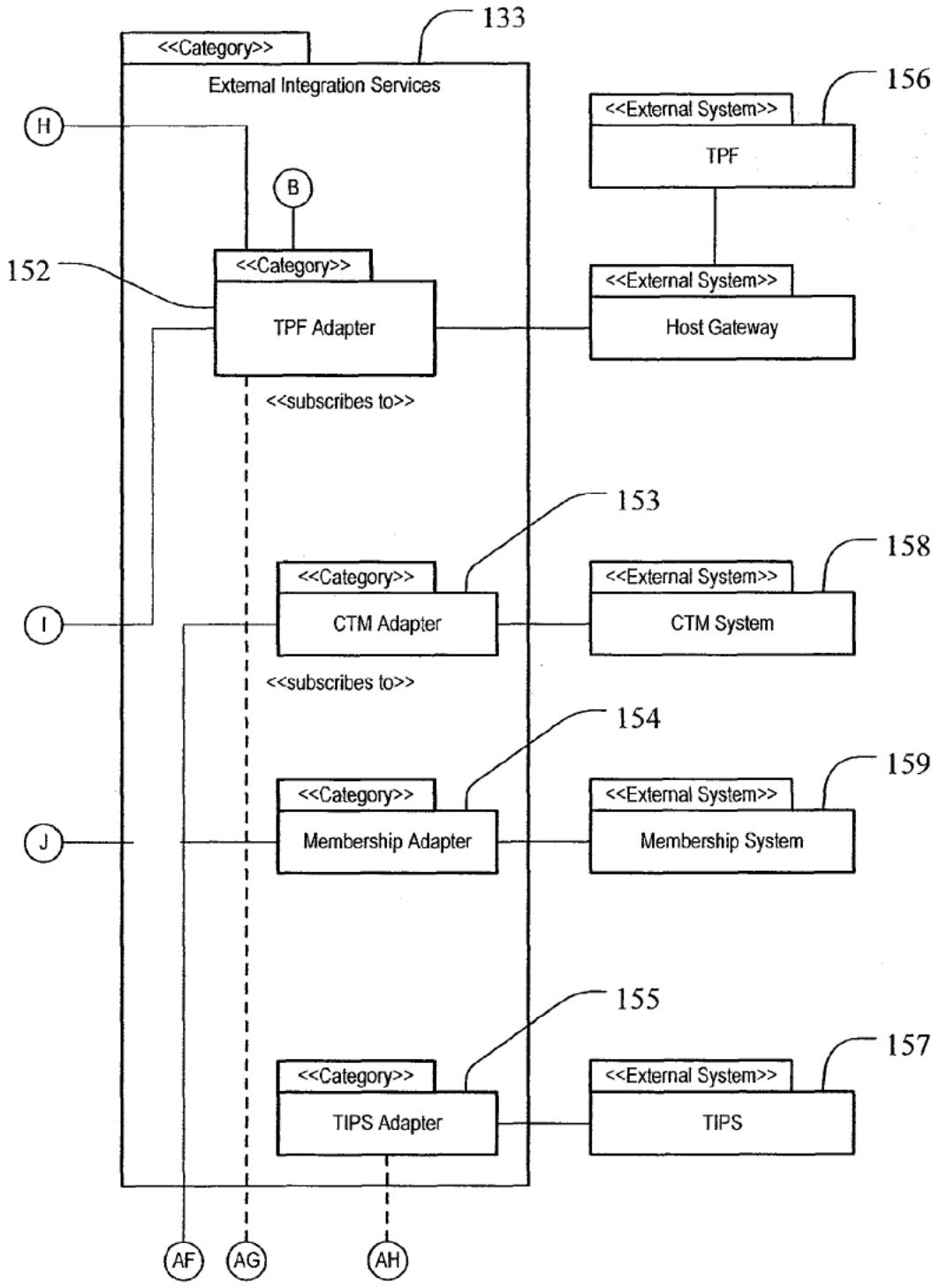
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Fig. 2C

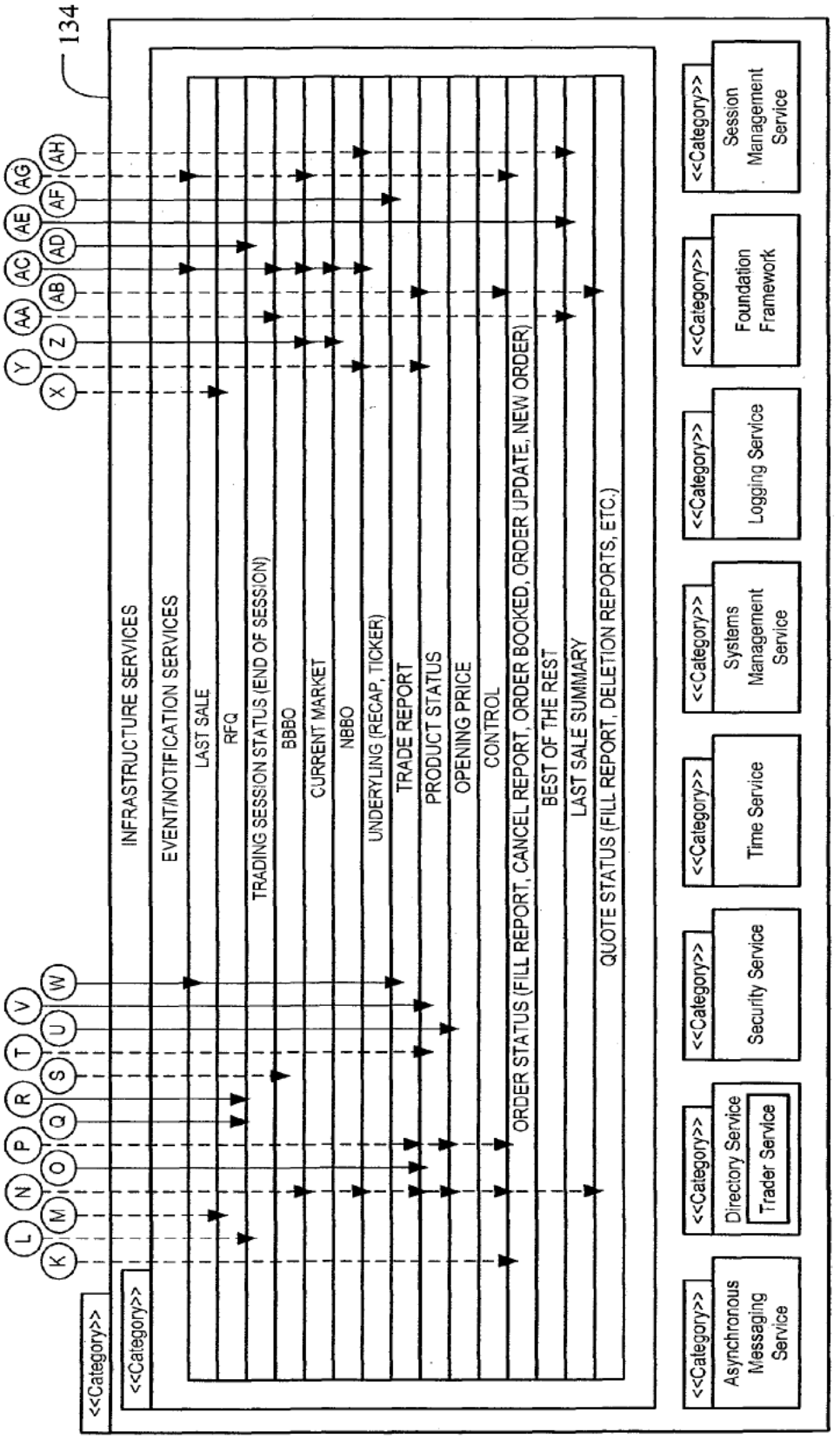


Fig. 2D

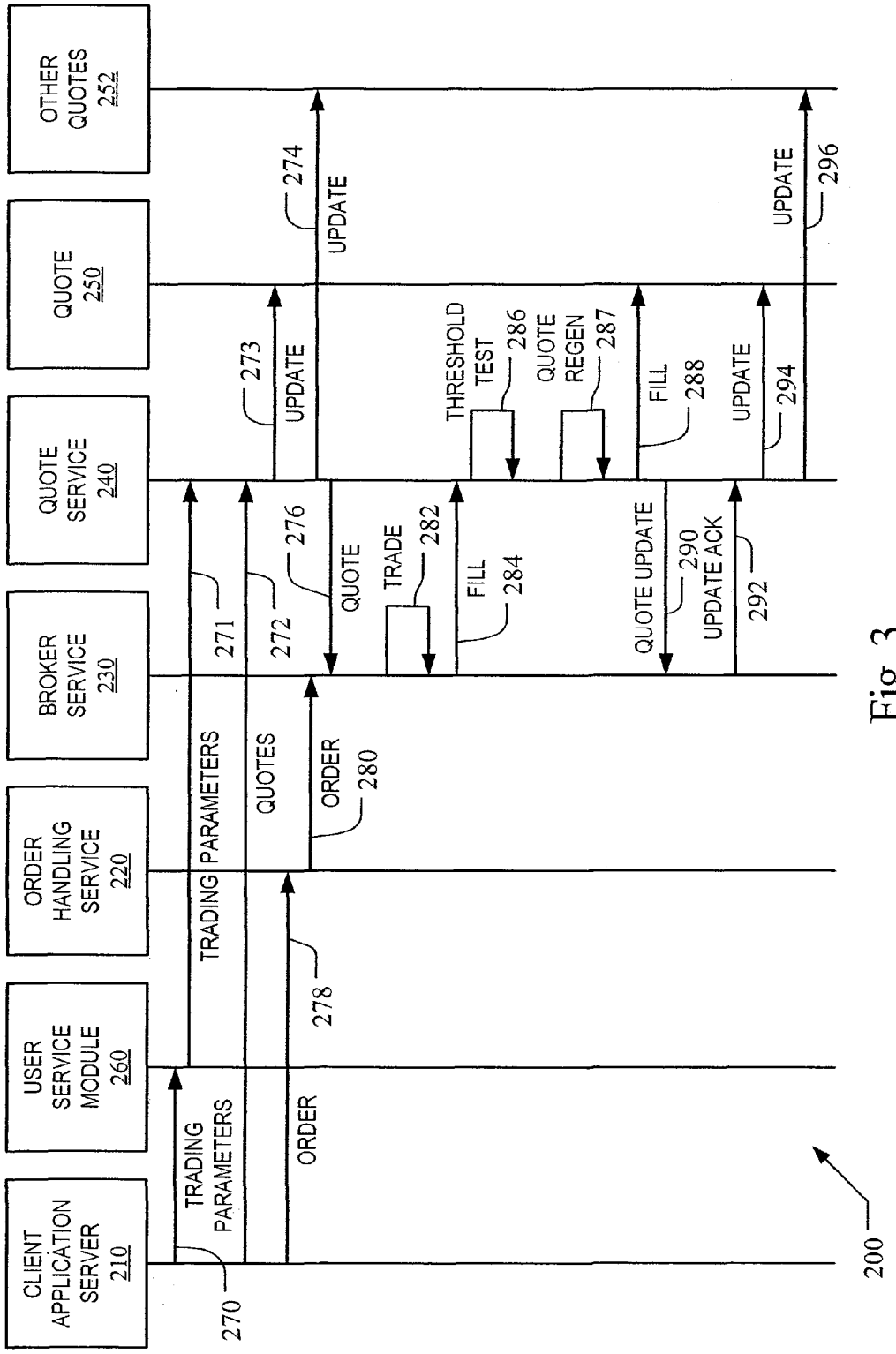
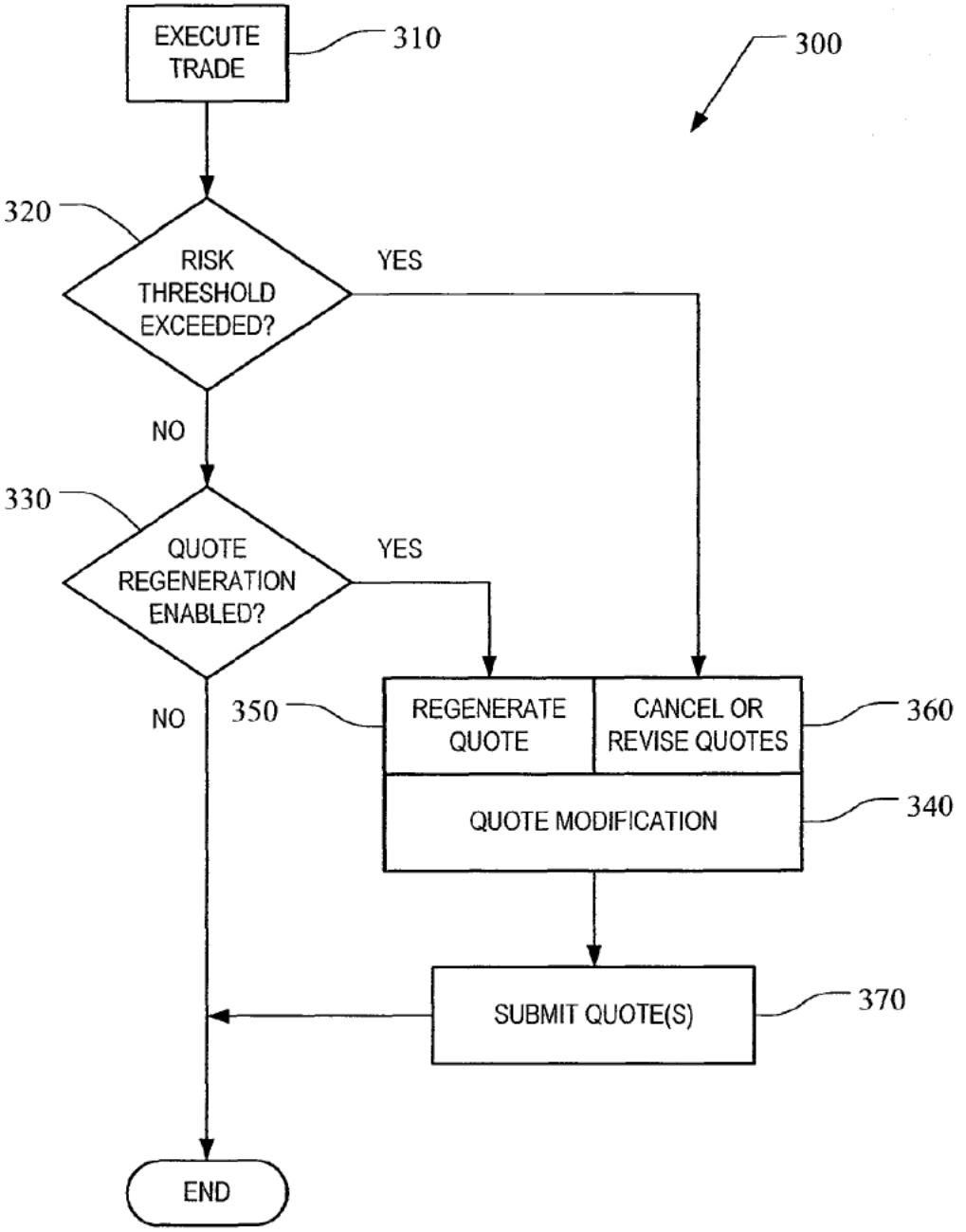


Fig. 3


EXECUTE TRADE
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RISK THRESHOLD EXCEEDED?
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CANCEL OR REVISE QUOTES
360
QUOTE MODIFICATION
340
SUBMIT QUOTE(S)
370
END

Fig. 4

AUTOMATED TRADING EXCHANGE SYSTEM HAVING INTEGRATED QUOTE RISK MONITORING AND INTEGRATED QUOTE MODIFICATION SERVICES

CROSS-REFERENCE TO RELATED APPLICATION

This application is a continuation of U.S. application Ser. No. 09/475,534, filed Dec. 30, 1999, now U.S. Pat. No. 7,356,498, the entirety of which is incorporated herein by reference.

A. FIELD OF THE INVENTION

The present invention relates to financial trading systems. More specifically, it is directed to a method and device for market-maker risk management through automatic quote risk monitoring and quote modification in an automated trading system.

B. DESCRIPTION OF THE RELATED ART

1. Option Trading

Option contracts are traded publicly on many exchanges throughout the world. These securities, referred to generally as "options," convey certain rights to buy or sell an underlying stock, commodity, or other security at a fixed price for a specific period of time—until expiration for an American-style option or at expiration for a European-style option. All option contracts that trade on U.S. securities exchanges are issued, guaranteed and cleared by the Options Clearing Corporation (OCC). OCC is a registered clearing corporation with the SEC.

The potential loss to the buyer of an option can be no greater than the initial premium paid for the contract, regardless of the performance of the underlying stock. This allows an investor to control the amount of risk assumed. On the contrary, the seller of the option, in return for the premium received from the buyer, assumes the risk of being assigned the obligation to buy or sell the underlying security if the contract is exercised. Therefore, writing options can lead to large potential exposure.

Further background information may be obtained from the book "OPTIONS, Special Concepts and Trading Strategies," The Options Institute, The Educational Division of the Chicago Board Options Exchange, Second Edition, McGraw Hill (1995), the contents of which are incorporated herein by reference.

2. Open Outcry Trading and Automated Exchanges

Many trading systems utilize what is known as an open outcry method of trading. In the open outcry system, market-makers are required to make a two-sided market by providing a bid and offer quote in all option series. The market-makers typically communicate verbally or visually with contra traders indicating their willingness to buy and sell various quantities of securities. Because the market-makers have personal control over the types and number of contracts traded, they can adjust their trading strategies as their positions change. In this way, the market-makers can manage their exposure, or risk, associated with their holdings by adjusting their quotes to favor trades that would tend to hedge away unwanted exposure.

In an automated trading environment, a certain amount of control is lost when a market-maker has issued quotes in a large number of option series. The quotes are typically recorded in the automated and computer-based trading system, and matched up automatically with orders that enter the system electronically. With the proliferation of computer trading systems and increased communication speeds, the rate at which trades may be executed by an automated system far surpass the rate of trades that occur in an open outcry system. The speeds are such that the rapidity of trades may exceed the market-maker's ability to adapt his or her position. Specifically, one disadvantage of automated trading systems is that a number Of automatic trades may occur within a very short time that result in an unacceptable risk being assumed by a market-maker. That is, the trades may occur so rapidly that the market-maker is unable to withdraw or modify his quotes in a timely manner.

There exist software tools that can analyze stock and option portfolios in close to real time. Market data is provided to the software analysis tools and used to evaluate the risk associated with stock and option portfolios. In addition, the tools may provide recommendations for trades and quotes and automated submission of those trades and quotes. However, even if a market-maker utilizes such a computer-implemented automated position analysis tool to revise or cancel quotes, the software tools may be unable to act in time given the speed at which an automated trading exchange system is capable of executing incoming orders. In particular, one aspect of existing exchange systems is that transactions are received and processed in the order received. Thus, even if a market-maker responds immediately using an automated software tool, the exchange may have a message queue containing additional orders that will be processed before the exchange system receives and processes the market-maker's quote cancellation request.

The result is that a market-maker who is willing to take on a predetermined level of risk must limit the number of quotes or the depth (quantity) of each quote to ensure that rapid trades do not result in an unacceptable aggregate risk, rather than issuing quotes having greater depth and breadth (where the filling of a single quote might reach the market-maker's risk limit). Thus, a market-maker's limited control over risk management may have the undesirable effect of hindering the liquidity of the market.

It would therefore be desirable to have a trading exchange system and method for automatically canceling, regenerating, or modifying quotes under certain trading conditions.

SUMMARY OF THE INVENTION

A method and apparatus for an automated trading exchange having integrated quote risk monitoring and quote modification services is provided. In accordance with a first aspect of the invention, an apparatus is implemented using at least one computer, having memory, a processor, and a communication port. The computer is configured to receive orders and quotes, wherein specified ones of the quotes are contained in a quote group, and have associated trading parameters such as a risk threshold. Note that not all received quotes are required to have trading parameters as described herein. Preferably, the quote group contains all the quotes belonging to an individual market-maker for a given class of options contracts, or possibly the quotes of two or more market-makers that have identified themselves as belonging to a group for the purposes of risk monitoring and quote modification. The computer typically generates a trade by matching the received orders and quotes to previously received orders and quotes, and otherwise stores each of the received orders and quotes if a trade is not generated. The computer then determines whether a quote within the quote group has been filled as a result of the generated trade, and if so, determines a risk level and an aggregate risk level associated with said

trade. The computer then compares the aggregate risk level with the market-maker's risk threshold, and if the threshold is exceeded, automatically modifies at least one of the remaining quotes in the quote group. The computer may also automatically regenerate quotes, that is, automatically issue new quotes when trades have occurred against previous quotes.

BRIEF DESCRIPTION OF THE DRAWINGS

The objects, features and advantages of the present invention will be more readily appreciated upon reference to the following disclosure when considered in conjunction with the accompanying drawings, in which:

FIG. **1** depicts a preferred embodiment of the quote modification trading system;

FIGS. **2**A, **2**B, **2**C, and **2**D show the interconnection of various software modules associated with the quote risk monitoring and modification trading system;

FIG. **3** shows a sequence diagram of a preferred embodiment of the quote modification system; and

FIG. **4** shows a flowchart depicting the method of modifying quotes.

DETAILED DESCRIPTION OF THE PRESENTLY PREFERRED EMBODIMENT(S)

With reference to FIG. **1**, a preferred embodiment of the system **100** utilized for trading and quote modification is described. The system **100** (also referred to herein as a screen-based trading system, or SBT system) includes a plurality of computers, which may be one or more workstations, servers, mainframes, or other computer hardware platforms that provide sufficient resources to meet the desired trading volume and desired transaction-processing rate. In the preferred embodiment shown in FIG. **1**, the system includes a number of computer clusters such as cluster **102** (although only one is depicted in FIG. **1**), where each cluster **102** handles trading for a number of securities, such as one or more classes of options. In the preferred embodiment, each cluster **102** is made up of two servers **104**, **106**. The servers **104**, **106** are preferably multiprocessor SUN **4500** servers available from SUN Microsystems of Palo Alto, Calif. SUN Enterprise™ servers or Starfire™ servers are a preferable alternative.

The servers **104** and **106** in cluster **102** communicate with a plurality of client servers **110**, **112** that are typically located at remote locations, such as at a brokerage house, but may also be located in the same facility as the clusters **102**. Network **108** facilitates communication between the clusters **102** and the client servers **110**, **112**. The network **108** is preferably a private LAN/WAN configuration, but a public network may be utilized, provided sufficient redundancies and message security are provided. Two such client servers **110**, **112** are shown in FIG. **1**. Each client server **110**, **112** may be provided with a predetermined message throughput rate into network **108**, where the throughput rate may be a maximum rate determined by various parameters, including the volume of orders sent by the client server **110**, **112**, the volume of quotes sent by the client server **110**, **112**, the number of option series for which quotes are provided, communication/connection fees paid by the brokerage house or other entity utilizing the client server **110**, **112**, the overall capacity of the trading system **100**, etc. The client servers **110**, **112** preferably communicate with other elements of the automated exchange system using a client application server module **210**, as further described below, running on client servers **110**, **112**.

Each client server **110**, **112** is capable of serving a number of clients, shown as terminals **114**, **116**, **118**, **120**, **122**, and **124** in FIG. **1**. The client terminals **114-124** may be "dumb" terminals, stand alone computing devices (PCs or workstations), or even portable wireless terminals. The client servers **110**, **112** may communicate with the client terminals **114-124** using a proprietary protocol or one of many standard public domain protocols. The client servers **110**, **112** may include a web server or connect to a separate web server for processing tcp/ip, http, html, java, and the like, and provide access to client terminals **114-124** over the Internet in addition to (or as an alternative to) private LAN/WAN or Virtual Private Network access. For embodiments that include a webserver, the web server preferably utilizes common gateway interface scripts (cgi) to interface with the client application server **210**. In addition to cgi scripts, or as an alternative to cgi, other web server interfaces and server extensions may be utilized to provide communication between the web server and the application server **210**. The client servers **110**, **112** communicate with the users of terminals **114-124** by way of secure Internet communication protocols or by private LAN/WAN or VPN communication links. Thus the client terminals **114-124** may run dedicated proprietary software to communicate with the client server **110**, **112**, or may interface with client servers **110**, **112** via a standard web browser. The web browser may operate using built-in java scripts, or may also include specialized browser modules that are provided to the client terminals.

The automated exchange system **100** is comprised of the following five logical software modules: Presentation Services Graphical User Interface (GUI) **130** (FIG. **2**A); Application Services **210** (Client Application Server, Gateway) (FIG. **2**A); Business Services **132** (FIG. **2**B); External Integration Services **133** (FIG. **2**C); and, Infrastructure Services **134** (FIG. **2**D).

With reference to FIG. **2**A, the Presentation Services GUI module **130** is constituted by applications that interact with the exchange system **100** via the Member Interface (MI) API **135**. There are two types of client applications, those that provide a GUI to allow user interaction with the system directly and applications that automate trading functions.

An SBT (screen-based trading) GUI module **131** is responsible for displaying the contents of a particular model to the screen and updating the display if the model's contents change. This module **131** contains several GUI applications, one for each of the major classes of human actors that use the system **100**: traders, market-makers, clearing firm brokers, and system operators. The Trader GUI is used by regular traders. It consists of several GUI's for displaying and entering orders, and market data. The Market-Maker GUI is an extension of the Trader GUI and is used by market-makers. It consists of several GUI's for displaying and entering orders, quotes, and market data. The Clearing Firm Broker GUI is an extension of the Trader GUI and used by clearing firm brokers. It consists of several GUI's for forcing the logout of a market-maker and for setting a maximum order quantity for the quotes and orders of the clearing firm's market-makers. The system operation GUI is used by system operators and help desk operators. The autoquote system **161** runs on the market-maker's work station and is used by the market-maker to generate quotes for various option series.

The Application Services module **210** contains subordinate modules that forward requests initiated by human or automated actors, to be executed by the appropriate Business Services module(s) **132**. These applications submit requests to Business Services components **132**, notify clients of business events, and maintain user-specific views of information

in the Business Services **132**. This module also encompasses a Member Interface (MI) API **135** that provides a single entry point to the system exposing the applications in the Application Services Module **210** (i.e., Trader, Market-Maker). In addition, the Application Services Module **210** maintains instantaneously updated views that reflect the prevailing state of each actor's information in the Business Services module **132**.

The Trader Application module **136** has the following specific responsibilities: submit, cancel, update, and cancel/replace orders; submit requests for quotes; present the current status of the trader's orders; present fill and cancel reports; present Market Best Bids and Offers for selected products; set the trader's defaults and preferences; present Book Depths for selected products; and, present underlying quotes/last sales and news alerts.

The Market-Maker module **137** inherits the Trader App module's **136** responsibilities and adds the following: submit and modify market-maker quotes; present requests for quotes; set the market-maker's defaults and parameters; set autoquote parameters; submit autoquotes.

The Clearing Firm Broker module **138** inherits the Trader App module's **136** responsibilities and adds the following: assume control of a trader's privileges. A Clearing Firm Broker can force the logout of a market-maker; set a maximum order quantity for quotes and orders of the clearing firm's market-makers.

The BackOffice application **139** is responsible for reporting order status information. This can include fill reports, cancel reports and new order notifications. The Operations application **140** has the following responsibilities: start and shutdown the SBT system; start and stop trading of a product; change the status of a product's market (pre-open, open, close, halt, etc.); present logged system events; maintain SBT-specific trader information; maintain SBT-specific product information; maintain trading parameters (quote width, minimum market-maker order default size, required percent of responses to a request for quote (RFQ), maximum response time to an RFQ; etc).

The functionality of the Trader **136**, Market-Maker **137**, Clearing Firm Broker **138**, and Back Office **139** modules is exposed by a facade, the Member Interface (MI) Application Programming Interface (API) **135**. The Member Interface **135** exposes different subsets of functionality depending on the user that logged on to the system. The intention behind sharing a common API among the different trader classes is to allow workstations to service all of them. Separate API's may alternatively be used for the different user classes.

The Member Interface API **135** supports both SBT client applications and external applications owned by members. Members use the Member Interface API to link their existing computer systems to the exchange system **100**, to submit orders electronically and to automate trading. Likewise, market-makers use the API to submit autoquotes employing their proprietary systems, instead of the default autoquote application **161** provided by SBT.

The following system functions are preferably accessible through the API: session logon and logoff; market state inquiry and change notification; connection status inquiry and change notification; order entry, cancellation, and replacement; quote entry, cancellation, and replacement; RFQ notification; order status inquiry and fill notification; subscription to product markets; best market quotes notification; book "depth" inquire and change notification.

Referring now to FIG. **2**B, the Business Services module **132** contains the core functionality of the automated exchange system **100**. It includes components that correspond to the key business object model entities of the automated trading system such as members, orders, books, products, quotes, et cetera. In addition, it includes components to administer and operate the system **100**.

The Order Handling Service module **220** maintains the current state of all orders persistently. Specific operations may be exposed directly by Order objects **141**, bypassing the Order Handling Service **220**. Logically, Orders are components of this module. Specifically, the Order Handing Service **220** and Order components are responsible for: receiving and storing incoming orders (from SBT clients or TPF **156**(FIG. **2**C)); forwarding incoming orders to the Broker module for execution; receiving order state change notifications from the Broker and Order Book modules and updating stored orders with this information (the functionality is provided by exposing Orders, allowing the Broker and Order Book components to directly update the orders); sending fill reports to originating traders upon receiving fill notifications from the Broker and Order Book modules; receiving order cancellation requests and forwarding them to the Broker and Order Book modules (upon confirmation of a cancellation, notifying the originating trader of the result of the request and updating the stored state of the order); and receiving order cancellation/replacement requests and forwarding them to the Broker and Order Book modules (upon confirmation of the cancellation/replacement, notifying the originating trader of the result of the request and updating the stored state of the order).

The Broker Service module **230** is responsible for executing the following types of orders: limit, market, all or none, fill or kill, immediate or cancel, stop, stop limit, and spread. Upon trade execution, the Broker Service **230** is responsible for notifying the Trade Service module **143** of all the orders matched (all parties to the trade) in the trade. It is also responsible for notifying the Order Handling Service (i.e. Orders) **220** and Market-Maker Quote Service (i.e. Quotes) **240** of the fills.

The responsibilities of the Order Book Service module **142** are: cooperate with the Broker Service **230** in calculating the opening price during a product's pre-opening period; acknowledge that an order was accepted by publishing an event consumed by the Trader application **136** which originated the order; cancel and cancel/replace resting orders; upon changes to the top of the book, publish the new Book Best Bid Offer (BBBO) and last sale.

The responsibilities of the Trade Service module **143** are: receive trade notifications from the Broker Service **230**; format trade reports; store trade reports; and forward trade reports to trade match (via TPF **156**).

The Market-Maker (MM) Quote Service module **240** is responsible for: receiving requests for quotes (RFQs) from traders; submitting RFQs to market-makers assigned to the product for which the quote was requested (by publishing in the RFQ event channel); receiving and logging market-maker responses to RFQs (market-maker quotes); upon receiving a market-maker quote, saving it persistently and submitting them to the Broker Service module **230** for execution; sending fill reports to originating market-makers upon receiving fill notifications from the Broker and Order Book modules; canceling or updating a Market-Maker quote upon receiving a request from the originating market-maker by submitting the request to the Broker/Order Book; canceling or updating or regenerating Market-Maker quotes upon receiving a fill report; upon inquiry, providing the history of the quotes submitted by a market-maker.

The Product Service module **144** maintains all product-related information. In order to perform its responsibilities, the Product Service module **144** downloads, and preferably caches, product information from TPF **156** and TIPS **157**. The User Service module **260** maintains all user-related information, both specific to SBT and contained in the Membership System. It provides a unified interface to SBT components accessing user information, hiding the actual location of the maintained data, thus simplifying client logic.

The User Service module **260** maintains the information of traders, market-makers, clearing firm brokers, operators, help desk personnel, back-office personnel. In one embodiment, the data is cached for performance reasons and the data is synchronized from the TPF **156** source.

The Trading Session Service module **145** maintains all business day and trading session-related information and manages the different states of a trading session, e.g. open, closed, and halted. Products that are processed/traded in each trading session are also kept at this service. In order to perform these responsibilities, the Product Service module **144** downloads trading session and product information from TPF **156**, as well as monitor events that affect products traded within a session.

The Product State Service **146** is responsible for coordinating product state changes for all products, e.g. pre-opening, opening, trading; halting, closing, and post-closing. It works closely with the Broker Service **230** to insure that state changes occur in a timely fashion. The service **146** monitors events that affect products traded, such as monitoring the underlying market to detect when the primary exchange opens, closes or halts trading a product. The Product Configuration Service **147** is responsible for providing the location of where a product is processed/traded. This information is primarily used to route product-specific requests (e.g. orders) for processing. The Order Status Service **148** provides subscription and notification services related to orders (i.e., fill reports, cancel reports, order accepted by book, etc.).

The Quote Status Service module **149** provides subscription and notification services related to quotes (i.e. fill reports, deletion reports, etc.) The service **149** preferably replaces the use of event channels for quote status reporting, providing a more secure mechanism for status delivery. The Market Data Service **150** maintains a current snapshot of market data, in addition to publishing market summary data. The module also provides an interface to clients to query historical market data.

The Best Quote module **151** is responsible for calculating the market best (aggregate quantities of buy and sell orders at the best price) for each product and sending them to TPF **156** (which in turn forwards them to the Options Price Reporting Authority) for public dissemination. In addition, it is responsible for calculating and disseminating the National Best Bid Offer (NBBO). In order to provide this information, the Best Quote module **151** subscribes to the event channel referred to herein as the Best of the Rest channel to obtain the current best quote from competing exchanges. The Best Quote module **151** then determines the source of the NBBO, whether it is from the present exchange or a competitor, and publishes the results to the Best Quote event channel, of which the TPF Adapter **152** is a subscriber.

Referring now to FIG. **2**C, the External Integration Services module **133** includes adapters **152**, **153**, **154**, and **155**, that map the interaction paradigms of external systems to the ones in the system **100** architecture. The adapter modules "adapt" (or "wrap") the native legacy interfaces to interfaces appropriate in the SBT environment. The TPF (Transaction Processing Facility) module **152** contains the adapter to allow SBT and TPF **156** to interact. TPF data is received, remoduled, and broadcast/delivered to the appropriate components within SBT. Conversely, SBT data is received, either through direct invocation or event consumption, remoduled, and sent to TPF **156** using its native interface.

The Membership Adapter **154** translates requests for member information received from SBT components into requests to the Membership System **159** and returns the results after reformatting.

The TIPS Adapter **155** subscribes to TIPS **157** to receive the external market data needed in the SBT environment, including underlying market data and the Best of the Rest of options listed in SBT. The Events Service (FIG. **2**D) notifies the TIPS Adapter **155** of consumer subscriptions so that it can propagate these subscriptions back to TIPS **157**. Once subscribed, the TIPS Adapter **155** reformats the market data received from TIPS **157** and publishes it for consumption by SBT components. Another responsibility of this adapter **155** is to publish underlying product state events when external markets change their states, for instance when they open, halt, close, etc.

The Trade Match Adapter **153** receives SBT data and forwards it to TM **158**. The TM Adapter **153** handles the following data flows: Trade Report (SBT to TM)—SBT reports all the parties to a trade to TM **158**.

Referring now to FIG. **2**D, the Infrastructure Services module **134** contains commercial "off-the-shelf" software and extended infrastructure services that provide enterprise-wide support to various other external systems. One mechanism by which the SBT system components interact with each other is by supplying and consuming events, implemented as a publish/subscribe pattern. The following list provides a brief description of the event flows/notification services (messaging services) shown in FIG. **2**D.

- RFQ—the Market-maker (MM) Quote Service supplies RFQ events consumed by the Market-Maker Application.
- BBBO—the Order Book supplies Book Best Bid Offer (BBBO) events consumed by the Best Quote Service.
- NBBO—the Best Quote Service supplies National Best Bid Offer (NBBO) events consumed by the Trader Application, and Market Data Service.
- Current Market—the Best Quote Service supplies Current Market Best events, containing a product's best quote, consumed by the Market Data Service and Trader Application. The best quote indicates if the exchange has the best quote.
- Best of the Rest—the TIPS Adapter component supplies best-of-the-rest events consumed by the Best Quote Service.
- Last Sale—the Trade Service supplies last sale events consumed by the Market Data Service **150** and TPF Adapter **152**.
- Last Sale Summary—the Market Data Service **150** component supplies last sale summary events consumed by the Trader application;
- Logging—the Logging Service Proxy component supplies Log Service events consumed by the Log Service component.
- System Management—the Foundation Framework supplies System Management events consumed by the System Management component.
- Instrumentation—the Instrumentation Service component supplies Instrumentation events consumed by both the System Management component and the Log Service component.

Underlying Ticker—the TIPS Adapter supplies Underlying ticker events (prices, quotes, last sales, news alerts) consumed by the Trader Application and the Product Service.

Underlying Recap—the TIPS Adapter supplies Underlying summary events (high and low prices, volume) consumed by the Market Data Service and Trader Application.

Trade Report—the Trade Service supplies Trade Report events consumed by the TPF Adapter **152**.

Product Status—the Product Service **144** and Product State Service **146** supply Product Status events (State, Price Adjustment, and Update) events consumed by the Trader application, Order Handling Service **220**, and TPF Adapter **152**.

Trading Session Status—the Trading Session Service **145** supplies Trading Session State events consumed by the Operations Application **140** and Help Desk application **160**.

End of Session Summary—the Trading Session Service supplies End of Trading Session Status events.

Opening Price—The Broker Service module **230** supplies Opening Price events consumed by the Trader Application **136**.

Control—the Operations **140** and Help Desk **160** applications supply Control events, possibly through the System Management component, consumed by Business Services **132** and External Integration Services **133** components.

Order Status—the Order Handling Service **220** (Order) supplies Fill Report, Cancel Report, Updated Order, New Order, and Order Accepted by Book events consumed by the Order Status Service **148**, and TPF Adapter **152**.

Quote Status—the MM Quote Service **240** (Quote) supply Fill Report, and Delete Report events consumed by the Quote Status Service **149**.

In accordance with a preferred embodiment, there are four major tiers of the application software. The business services **132** handle all the SBT order matching, execution and reporting functionality. It provides the repository for all SBT information data. The application services **210** handle the application presentation and act as the application front end to the business services. Different views of the business services **132** and collaboration of business objects are grouped together and are presented to the user based on logon authentication and authorization level. The two tiers communicate to each other by two supported tiers: the infrastructure services **134** and external integration services **133**. The infrastructure services **134** provide a seamless integration between the application services **210** and business services **132**. The external integration services **133** provide the access to the external system.

With reference to FIG. **3**, a sequence diagram **200** for a preferred embodiment of the automated exchange system **100** is shown. The system **100** includes a client application server **210**, an order handling service module **220**, a broker service module **230**, a quote service module **240**, a user service module **260**, and quote objects **250** and **252**. The service modules **220**, **230**, **240**, **260** and objects **250**, **252** are preferably software modules running on clusters **102**, or on one or more interconnected computers. The software modules are preferably written in an object-oriented programming language and are compiled to run on the clustered computers **102**. Preferably, the software utilizes the C++ language, the Java programming language, or other object-oriented language. Alternatively, any suitable software language may be used to implement the system, as will be understood by one of ordinary skill in the art. The modules also interact with a database program used for storing data and other system and user information. In the preferred embodiment an Oracle database system is used.

The client application server **210**, as discussed above, runs on client servers **110**, **112**, and provides an interface to one or more clients. The client server **110**, **112** may include one or more application modules, depending upon the intended users of the servers **110**, **112**. For example, the client servers **110**, **112** preferably include at least one of a market-maker application, a trader application, a back-office application, or a member interface. The client servers **110**, **112** also preferably utilize a user authentication and role-based security model to control access to the various application modules.

The client server **110**, **112** may also include modules such as a help desk application, an operations application, and a Clearing Firm Broker (CFB) module. The CFB module may be configured to allow a Clearing Firm to set maximum volume limits on a per-class basis. The Help Desk module is preferably enabled for use on client servers that provide connectivity to exchange management personnel. The Help Desk provides a utility to force a user to logout of the system.

The order handling service **220** forwards orders to the appropriate broker service module **230** that handles the class of options to which the individual orders relate. If the broker service module **230** cannot execute the order immediately, it routes it to the order book service module, which maintains the current state of all pending orders and quotes. The order handling service module **220** receives order information from various sources, including brokers, traders, market-makers, etc. The orders may enter the system from a client application server **210** or through an alternative interface such as TFP adapter **152**, which is a connection that allows a pre-existing automated order handling system such as TPF system **156**, to access the present system.

The broker service module **230** is responsible for executing various types of orders, including limit, market, all or none, fill or kill, immediate or cancel, stop, stop limit, and spread orders. Preferably, there are numerous broker service modules **230** running on the exchange server **104**, or on the interconnected computers in the cluster **102**, where each broker service module **230** handles trades for a subset of products offered by the exchange. For example, there is preferably a broker service module **230** for each class of option contracts. The broker service module **230** thus matches incoming orders to other orders or to quotes supplied by market-makers to complete a trade, indicated by line **282** in FIG. **3**.

The broker service module **230** also receives quotes from the quote service **240**, discussed below. The broker service module **230** attempts to execute a trade **282** by matching incoming quotes to orders or to other quotes stored by the order book service module **142** in the order book. Note that for purposes of trade execution **282**, quotes are treated by the exchange system **100** as if they were orders. Thus, when the broker service module **230** receives a quote that it cannot match to an existing order or quote, it sends the quote to the order book for storage with other unfilled quotes and orders. Preferably, quotes differ from regular orders in that a quote may be two sided, having a bid and an offer price, and that each market-maker may only have one quote per product in the system.

To facilitate the order matching process of trade execution **282**, the broker service module **230** has direct access to orders stored in the order book by the order book service module **142**. Preferably, when the incoming order is matched to an

existing quote supplied by the quote service module **240**, the broker service module **230** provides the quote service module **240** with details of the trade.

The quote service module **240** manages the quotes supplied by market-makers via client application service module **210**. The quote service module **240** submits the quotes to the broker service module **230** for execution. The quote service module **240** ensures that each individual market-maker has only one quote per product in the system at any given time. When a market-maker enters a new quote on a product for which he already has an outstanding quote, the quote service module preferably determines whether there is already an existing quote in the system for that market-maker and, if so, informs the broker service module **230** that the pre-existing quote is to be cancelled. The quote service module **240** submits the new quote to the broker service module **230** only after it has received acknowledgement from the broker service module **230** that the pre-existing quote has been cancelled.

The broker service module **230** issues fill reports to notify various other modules, and ultimately the trading entities, that the trade was executed. Upon notification of a fill **284** from the broker service module **230** (or the order book module), the quote service module **240** informs the quote object **250**. In turn, the market-maker is notified of the fill via the exchange's reporting system. The quote service module **240** also cancels or updates a market-maker quote upon receiving a request from the originating market-maker by submitting the request to the broker service **230**. The quote service module performs this by first informing broker service module **230** that the pre-existing quote has been cancelled. The broker service module **230** then removes the quote from the order book and confirms to the quote service **240** that the quote has been cancelled. The quote service **240** then submits the new quote (if one exists) to the broker service module **230**.

With respect to FIG. **3**, a preferred sequence of events and messages will be described. Market-Makers log into a client application server module **210** and access the user service module **260**. The market-maker communicates with the user service module **260** through a terminal, such as a workstation or wireless handheld unit. As shown by line **270**, trading parameters, or quote parameters, are sent to the user service module **260**. Upon initialization of the quote service, or upon login of a new market-maker, various trading parameters are provided to the quote service module **240** as shown by line **271**. The trading parameters may include a risk threshold, a quote regeneration indicator, a quote regeneration increment, a quote modification indicator, and a quote modification increment. The parameters may include numerous sets of thresholds, indicators, and increments, preferably one such set for each class for which the market-maker is providing quotes.

The quote service module **240** receives quotes from market-makers as shown by line **272**, and provides these quotes to the quote objects **250**, **252**, as shown by update lines **273**, **274**, and to the broker service module **230** as shown by line **276**. As mentioned above, the quote service module **240** will not forward updated quotes (as opposed to new quotes) to the broker service module **230** before first canceling old quotes.

Orders received by the client application server **210** are routed to the order handling service **220** as shown by line **278**. The order is then forwarded to the appropriate broker service **230** as shown by line **280**. The broker service module **230** attempts to execute every order or quote received with the best order (or quote) in the book as shown by line **282**. When a trade is executed, a fill report is issued to the quote service module **240** as shown by line **284**. The quote service module **240** then analyzes the trade and determines whether the market-maker's risk threshold has been exceeded, as shown by line **286**. The threshold test will be described in further detail below. A fill report is sent to the quote object **250** as shown by line **288**. The quote object **250** then informs market-maker of the fill through the use of a trade report service module (not shown).

In addition, at steps **286** and **287**, the quote service module may modify quotes in response to the trade in accordance with the market-maker's trading parameters, as discussed below. The quote service module then reports the new quotes to the broker service module **230** as shown by line **290**. The broker service **230** acknowledges the quote updates as shown by line **292**. If the broker service **230** has already processed additional trades against the original quote, then the broker service module **230** would respond with a "too late to cancel" message. Once the update acknowledge has been received, the quote service module **240** updates the quote objects **250**, **252**, as shown by lines **294**, **296**. The quote objects then inform the market-maker that its quotes have been updated.

Risk Measurements and Risk Thresholds

In a preferred embodiment of the automated trading system **100** having integrated order modification and quote risk monitoring, the aggregate risk of a market-maker's recent trades is calculated after each trade. The measurement preferably includes either calculating an equivalent stock position, i.e., a net delta (by, for example, summing delta values for all contracts traded by the market-maker associated with the option series in the class), or calculating a net gamma, theta, or vega.

In particular, the aggregate risk measurement is preferably the net delta of all the trades for a specific market-maker or a designated group of market-makers in a given class in a given period of time. The quotes in a given class submitted by a market-maker (or a group of market-makers) are referred to herein as a quote group. The rules for delta calculations are as listed below:

Calls (delta value Δ is positive)
- Market-maker selling
- Market-maker position will be Negative Delta
- Market-maker buying
- Market-maker position will be Positive Delta

Puts (delta value Δ is negative)
- Market-maker selling
- Market-maker position will be Positive Delta
- Market-maker buying
- Market-maker position will be Negative Delta

The aggregate risk net delta is defined as:

$$\Delta_{NET} = \sum_i S_i \cdot \Delta_i \cdot U_i \cdot K_i, \quad (1)$$

which is the summation for i trades of the product of S, the sign of the trade, where S is positive when a market-maker buys and negative when a market-maker sells, Δ (delta), which is rate of change of the price of the individual series with respect to the stock, and ranges from −1.0 to 0 for puts and 0 to 1.0 for calls, U, which is the unit of trade, i.e. the number of shares, and K, the number of contracts traded by the market-maker.

The aggregate risk measurement is preferably based on the net delta Δ_{NET} for the entire class of options, which is the sum of all the deltas for a given market-maker's trades in all series of a class. The delta contribution for each trade is calculated every time a trade occurs for any series in the class. The aggregate risk is then calculated by summing delta contribu-

tions from only the most recent trades. The values for the theoretical deltas Δ, are preferably obtained by an autoquote system (not shown) associated with the exchange system **100**, and more particularly with the business services package **132**.

Autoquote systems provide pricing information, and specifically theoretical delta values Δ_i, using well-known algorithms that utilize standard parameters, as is understood to those of skill in the art. Most of the parameters associated with calculating an individual series delta value are objective data, such as the date, strike price, the price of the underlying security, etc. Other autoquote parameters have acceptable default values that may be used, such as using the broker loan rate for the interest rate, etc. One parameter that may be more subjective among individual market-makers is the volatility parameter. Thus, the system **100** may be designed such that each quote submitted by a market-maker includes a volatility field to be used by the system in determining the individual theoretical delta value Δ_i. The theoretical delta value Δ_i may then be calculated either as part of the threshold test, or may be periodically updated at a rate sufficient to provide a fairly accurate delta value Δ_i. In this way, the system **100** provides the market-maker with further control over the quote risk monitoring system.

Because the exchange quote modification service is intended to address increased risks associated with a rapid sequence of trades, older trades need not be included because the market-maker has had an opportunity to manually intervene and modify his quotes. Thus, the aggregate risk measurement may be based on the last N trades, where N is a trading parameter specified by the market-maker, or may be based on trades occurring within a specific time frame. The duration of the time frame may be specified by the market-maker by providing a time window parameter t_K, which is included as a trading parameter. Alternatively, a default value for t_K may be used.

Alternatively, the risk threshold and risk measurement may include an aggregate gamma measurement. Gamma is known to those of skill in the art to be the rate of change of the delta parameter with respect to the rate of change of the underlying security, such as the stock. An aggregate gamma measurement provides an indication of the rate at which an aggregate delta measurement will change. Net gamma values are negative when a market-maker is a net seller of contracts, and positive when a market-maker is a net buyer of contracts. As a further alternative, either theta, which is the rate at which option prices change over time, or vega, which is the change in an option contract that results from a change in its volatility, may be included.

The market-maker may provide a single threshold Δ_{NETMAX} such that if the absolute value of the aggregate risk exceeds the threshold, then the quotes are modified according to the rules set forth below. The market-maker may also provide positive and negative thresholds Δ^{+}_{NETMAX} and Δ^{-}_{NETMAX} to accommodate a market-maker's pre-existing risk bias.

In an alternative preferred embodiment, the market-maker's risk is determined by calculating the net contract volume traded within a specified time. The net contract volume K_{NET} may be calculated by using equation (1) above, with the exception that the delta value is replaced by the sign of Δ, or ±1, where calls are positive 1, and puts are negative 1:

$$K_{NET} = \sum_i S_i \cdot \text{sign}(\Delta_i) \cdot U_i \cdot K_i, \text{ for each trade, } i. \quad (2)$$

The result is that the volume of each trade is treated as a positive or negative value, depending upon the nature of the trade—selling calls and buying puts have negative contributions, and buying calls and selling puts have positive contributions. The sum of the trades is then calculated to provide a net difference between the number of short calls plus long-puts and long calls plus short puts. Thus, the market-makers may specify a threshold in terms of a maximum net contract volume offset, K_{NETMAX} (or positive and negative thresholds K^{+}_{NETMAX} and K^{-}_{NETMAX} to accommodate a market-maker's pre-existing risk bias). As stated above, the system may be configured to also allow the market-makers to specify a time window parameter t_K that specifies which trades should be included in the risk calculation. Thus, only the contracts K that have been executed within the previous t seconds will be included in equation 2. Alternatively, the system may be configured to specify i, the number of previous trades to include in the risk calculation.

In still further embodiments, the aggregate risk measurement may be simplified by calculating the total number of put or call contracts (or deltas) that have been sold or bought within a given time frame or within that last N trades. Thus, for example, when a market-maker has just sold a put, the quote service module **240** may calculate the total number of puts sold (or the delta due to all the puts sold) within the given trading window and compare it to a threshold. If the next trade is a call purchase, then the system would calculate the contracts or deltas for the calls purchased. Thus, if any of the four aggregate volume quantities (buying calls, selling calls, buying puts, selling puts) exceeds a threshold (within a certain time period, or certain number of trades), the quote-modification module **340** modifies the quotes appropriately. Alternatively, the quote service module **240** may calculate the total calls bought plus puts sold, and the total calls sold plus puts bought, and notify the quote modification module **340** if either of these aggregate values exceeds the threshold. As a further alternative, the quote service module may use a weighting scheme to calculate aggregate values described above. Specifically, in-the-money options (options with intrinsic value) may be weighted more heavily than at-the-money or out-of-the-money options. In one preferred method, the in-the-money options are weighted with a factor of two, at-the-money options are weighted with a factor of one, and out-of-the-money options are weighted by a factor of one half. These simplified risk measurement and threshold tests perform adequately due to the nature of trading activities that typically result in large risk exposure.

It should also be noted that the market-makers may be grouped together for purposes of risk exposure analysis. That is, the total risk may be calculated based on the trades of one or more market-makers. The market-makers provide a group identification parameter(s) indicating which other market-makers' trades should be included in the risk calculation. In this manner, market-makers acting in concert on behalf of a single organization may coordinate their quote modification.

Automatic Quote Modification

The quote service module **240** of the exchange system **100** includes a quote modification service module **340**. The quote modification service module **340** may be implemented as part of the quote service module **240**, or may be a separate service module. It may also take the form of a separate quote factory module for generating new instantiations of quote objects. The quote modification service module **340** performs quote modification by preferably automatically revising, canceling, or regenerating quotes. The quote modification service module **340** resides on the exchange system computer **104**, **106**, or computer cluster **102**. The quotes are modified by the

exchange system in an automatic manner that does not require further input from the market-maker in the form of quote cancellation requests and submission of new quotes by the market-maker or his computer. In this way, the exchange system performs quote modification immediately and without the transmission delays inherent in communication systems and without delays associated with processing queued cancellation requests received from a remote location.

If the quote service module **240** determines that the threshold(s) have been exceeded, the quote service module **240** determines revised quotes and forwards them to the broker service module **230** and the quote objects **250**, **252**. The revised quotes can take numerous forms. In a first embodiment, the quote service module **240** revises quotes by canceling all outstanding quotes in the class, thereby preventing any further trades from executing and giving the market-maker time to provide revised quotes. In this embodiment, the quote service module **240** sends quote update messages **290** in the form of cancellation messages to the broker service module **230**. The broker service **230** then removes those quotes from the electronic book. Because the threshold test is performed by the exchange system **100** after each trade, the cancellation messages are therefore preferably processed before any further trades can be executed. This is possible because the cancellation requests are not sent from a remote node on a wide area network, such as a market-maker's computing platform, but are generated by the exchange system **100**. This provides the advantage of eliminating a cancellation message queue, as would be used when sending cancellation requests from a remote node, thereby improving quote update times and providing risk management.

In a second embodiment, the quote service module **240** revises quotes by reducing the quantity associated with the existing quotes in the class thereby reducing the amounts of potential further trades and reducing the market-maker's exposure to more risk. The market-maker may specify the amount of the volume decrease by way of an increment value. In this embodiment, the quote service module **240** sends quote updates **290** by first sending quote cancellation messages to the broker service module **230**, and after acknowledgment, sending the revised quotes to the broker service module **230** for execution or booking. Again, because the threshold test is performed by the exchange system **100** after each trade, the cancellation messages are therefore preferably processed before any further trades can be executed. As above, this is possible because the cancellation requests are not sent from a remote node on a wide area network, such as a market-maker's computing platform, but are generated by the exchange system **100**.

In a third embodiment, the quote service module **240** revises quotes by decreasing the bid and offer values of some quotes and increasing others in an attempt to cancel some of the risk already assumed by the market-maker. The quote service **240** does this by automatically adjusting quotes to favor trades that will tend to provide offsetting risk. Specifically, if the threshold (K_{NETMAX} or Δ_{NETMAX}) has been exceeded by a high positive-valued net delta (or K), then the net delta (or K) may be offset by trades having a negative delta (or K). As set forth above, those trades would include selling calls and buying puts. Similarly, if the threshold has been exceeded by a high negative-valued net delta (or K), then the aggregate risk may be offset by trades having a positive delta (or K), or by selling puts and buying calls. Of course, to produce the desired trades, the lowering of offer values of quotes will tend to result in more selling activity by the market-maker, and the raising of bid values will result in more buying activity by the market-maker. In this embodiment, the modification increment is specified by an increment value. As in the previous embodiment, the quote service module **240** sends quote updates **290** by sending quote cancellation messages to the broker service module **230**, and after acknowledgment, sending the revised quotes to the broker service module **230** for execution or booking. Again the automated risk monitoring system and quote modification service of system **100** provides advantages in that the market-maker need not cancel previous quotes and submit new quotes while still being exposed to the possibility of further trades being executed.

The quote service **240** may also modify quotes by regenerating the just-filled quote. This may be performed even if the market-maker's risk threshold has not been exceeded. The market-maker is able to specify quote regeneration parameters via client application server **210** that are stored in the user service module **260**. The parameters specify which products are enabled for quote regeneration, and the extent to which the quotes are to be regenerated. The market-maker may therefore specify, on a product-by-product basis, how many times the quotes are to be regenerated after each quote has been filled. This is referred to herein as the regeneration number parameter. The market-maker may also specify whether the regenerated quotes are to have the same bid and offer values, or are to be backed-off from the previous trade. This parameter is referred to herein as the regeneration increment. That is, for a two-sided quote, if the market-maker has just sold a quantity of contracts at his offer price, the regenerated quote may have a higher offer value. Preferably the bid value is also raised accordingly to maintain a desired or required spread in bid and offer quotes. If, on the other hand, the market-maker has just bought a quantity of contracts at his bid price, the regenerated quote may have a lower bid value. The market-maker also has the option of specifying on a per-class basis the values of the regeneration number parameter and the regeneration increment parameter. The quote regeneration is preferably not performed if the market-maker risk threshold has been exceeded, unless the market-maker has specifically selected quote revision in the event the risk threshold has been exceeded.

With reference to FIG. **4**, the method of quote modification **300** will be described. Upon execution of a trade at step **310**, the quote service module **240** at step **320** checks to see whether the individual market-maker's risk threshold has been exceeded. As mentioned above, the risk measurement and threshold test may be performed using a variety of methods, and certain market-makers' trading activities may be combined for the purposes of risk exposure. If the threshold has not been exceeded, then at step **330** the quote service module **240** preferably checks to see whether the market-maker whose quote has been executed has indicated the desire to have his quotes regenerated. If not, then the process has completed. In the event that the result of either inquiry **320**, **330** is affirmative, then the quote service **240** modifies the quotes with the quote modification module **340** as described above.

Quote modification module **340** includes quote regeneration module **350** and cancel or revise quote module **360**. As mentioned above, the quote modification module **340** may be integral to quote service module **240**, or may be included in a quote factory module, or may be a separate service module. The quotes are regenerated, cancelled, or revised, for example as described above, and submitted as shown in step **370** to the broker service module **230** for execution.

Preferred embodiments of the present invention have been described herein. It is to be understood, of course, that changes and modifications may be made in the embodiments

without departing from the true scope of the present invention, as defined by the appended claims. The present embodiment preferably includes logic to implement the described methods in software modules as a set of computer executable software instructions. A Central Processing Unit ("CPU"), or microprocessor, implements the logic that controls the operation of the transceiver. The microprocessor executes software that can be programmed by those of skill in the art to provide the described functionality.

The software can be represented as a sequence of binary bits maintained on a computer readable medium including magnetic disks, optical disks, and any other volatile or (e.g., Random Access memory ("RAM")) non-volatile firmware (e.g., Read Only Memory ("ROM")) storage system readable by the CPU. The memory locations where data bits are maintained also include physical locations that have particular electrical, magnetic, optical, or organic properties corresponding to the stored data bits. The software instructions are executed as data bits by the CPU with a memory system causing a transformation of the electrical signal representation, and the maintenance of data bits at memory locations in the memory system to thereby reconfigure or otherwise alter the unit's operation. The executable software code may implement, for example, the methods as described above.

It should be understood that the programs, processes, methods and apparatus described herein are not related or limited to any particular type of computer or network apparatus (hardware or software), unless indicated otherwise. Various types of general purpose or specialized computer apparatus or computing device may be used with or perform operations in accordance with the teachings described herein.

It should be understood that a hardware embodiment may take a variety of different forms. The hardware may be implemented as an integrated circuit with custom gate arrays or an application specific integrated circuit ("ASIC"). Of the course, the embodiment may also be implemented with discrete hardware components and circuitry. In particular, it is understood that the logic structures and method steps described herein may be implemented in dedicated hardware such as an ASIC, or as program instructions carried out by a microprocessor or other computing device.

The claims should not be read as limited to the described order of elements unless stated to that effect. In addition, use of the term "means" in any claim is intended to invoke 35 U.S.C. §112, paragraph 6, and any claim without the word "means" is not so intended. Therefore, all embodiments that come within the scope and spirit of the following claims and equivalents thereto are claimed as the invention.

We claim:

1. A system for processing trades of securitized instruments based on security orders and quotes received from client computers, comprising:

at least one server computer comprising a memory, and a processor, said server computer configured to perform the steps of:

receiving orders and quotes, wherein specified ones of said quotes belong to a quote group, and wherein said specified ones of said quotes have associated trading parameters comprising a risk threshold;

generating a trade by matching said received orders and quotes to previously received orders and quotes;

storing each of said orders and quotes when a trade is not generated;

determining whether a quote having associated trading parameters has been filled as a result of the generated trade, and if so, determining a risk level and an aggregate risk level associated with said trade;

comparing said aggregate risk level with said risk threshold; and,

automatically modifying at least one of the remaining specified ones of said quotes in the quote group if said threshold is exceeded.

2. The apparatus of claim **1** further comprising a quote data structure stored in said first memory, said data structure containing a plurality of quotes fields and at least one risk threshold field.

3. The apparatus of claim **2**, wherein said plurality of quote fields comprises a bid quote field and an offer quote field.

4. The apparatus of claim **2**, wherein said data structure further comprises a group indicator field.

5. The apparatus of claim **2**, wherein said data structure further comprises a quote modification increment field.

6. The apparatus of claim **2**, wherein said data structure further comprises a quote regeneration increment field.

7. The apparatus of claim **2**, wherein said data structure further comprises an owner field.

* * * * *

United States Court of Appeals
for the Federal Circuit

International Securities Exch. v. Chicago Board Options Exch., 15-1743, -1744

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